ARIZONA DROUGHT PREPAREDNESS

ANNUAL REPORT

2020

FOR WATER YEAR 2020:
OCTOBER 1, 2019 – SEPTEMBER 30, 2020

SAGUARO NATIONAL PARK

ACKNOWLEDGMENTS

The Arizona Drought Preparedness Plan was adopted in 2004 and its continued implementation ordered in 2007 (Executive Order 2007-10). The Arizona Department of Water Resources (ADWR) prepares an annual report based on drought updates from the Drought Monitoring Technical Committee (MTC), Governor's Drought Interagency Coordinating Group (ICG), Local Drought Impact Groups (LDIGs), and others. The Arizona 2020 Drought Preparedness Annual Report covers the drought conditions and preparedness activities for Water Year 2020, from October 1, 2019 through September 30, 2020. ADWR acknowledges and thanks all who contributed to this report.

LAKE POWELL

2020 ARIZONA DROUGHT PREPAREDNESS ANNUAL REPORT

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2020 ARIZONA DROUGHT PREPAREDNESS ANNUAL REPORT

1. INTRODUCTION

The current drought in Arizona began in the mid-1990s. Since then, only seven of the last 26 years have been wetter than the long-term annual average statewide. Total precipitation during Water Year 2020 was below-average for most of the state. While the winter was wetter than average in most parts of the state, except the Four Corners area, summer was the driest on record for much of Arizona producing a minimal monsoon season for the second year in a row.

The state received above-average precipitation from November 2019 through March 2020. The well-above average snowpack and streamflow led to a significant reduction of Exceptional Drought (D4), Extreme Drought (D3), and Severe Drought (D2) across most of the state, except in the northeast plateau. This past winter the Upper Colorado River Basin received less moisture than in previous years, and as a result Lake Powell and Lake Mead did not receive as much runoff as expected. However, there was a significant water level increase in the Salt-Verde reservoir system.

The 2020 monsoon activity was virtually non-existent, bringing a second consecutive year of below-average rainfall. The lack of monsoon precipitation reversed the winter improvement in drought conditions across the eastern half of the state. This led to the return of long-term drought conditions, particularly in the northeast Colorado Plateau.

Arizona's Drought Preparedness Plan activities continue to provide a framework to monitor drought conditions in the state, improve understanding of drought impacts, and determine mechanisms for limiting future vulnerability.

2. DROUGHT STATUS SUMMARY

2.A. WINTER PRECIPITATION: OCTOBER 2019 – APRIL 2020

Winter of 2018-2019 **(Fig. 1)** was extremely wet, with the entire state receiving 100% or more of its normal precipitation. The Upper Colorado River Basin (CRB) was also very wet receiving over 129% of normal precipitation. Winter 2019-2020 **(Fig. 2)** was also wetter than normal in Arizona although much of the Upper CRB received less than 90% of normal precipitation.

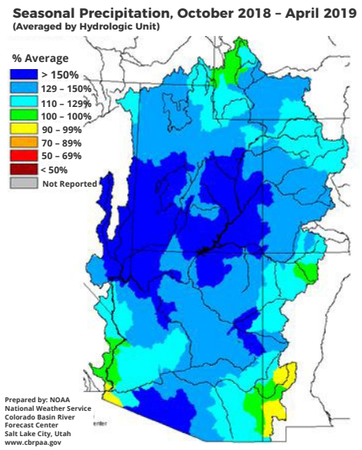


Figure 1. Precipitation Oct. 2018-Aprl 2019

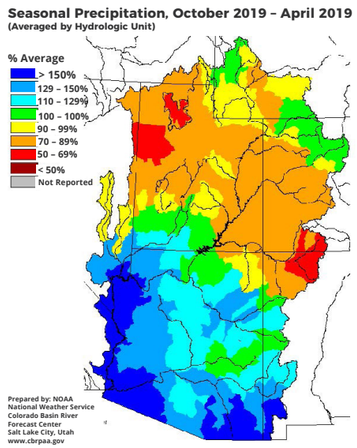


Figure 2. Precipitation Oct. 2019-Aprl 2020

Early winter snow fell on saturated ground as November and December were very wet, with additional precipitation in February and March. The Upper CRB had relatively dry soil beneath the snowpack and after December, snow was scarce as January, February, and April were much drier than normal.

2.B. MONSOON PRECIPITATION: JULY – SEPTEMBER 2020

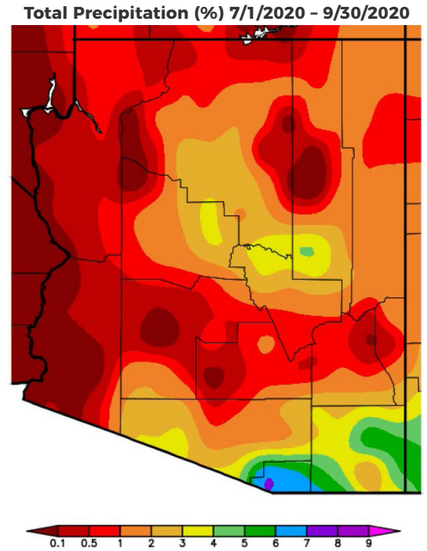


Figure 3. Precipitation July-Sept. 2020

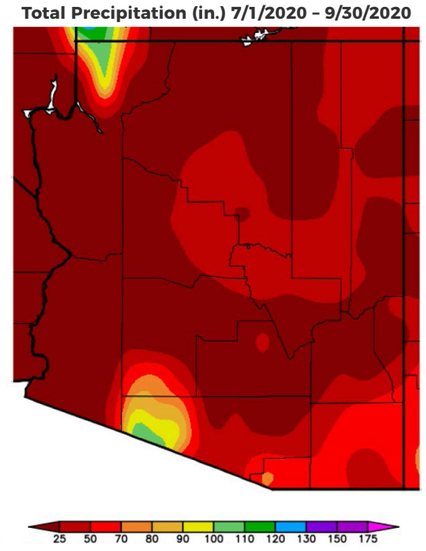


Figure 4. Precipitation Oct. 2019-Aprl 2020

The 2020 monsoon season was Arizona's second consecutive drier than average monsoon season. Less than 4" of rain fell across most of the state, while the southeast, specifically Santa Cruz County and parts of Cochise County, received 4" to 7" of rain **(Fig. 3 and 4)**. This amounts to less than 50% of average precipitation across most of Arizona and 50-70% of average precipitation in Cochise and Santa Cruz counties. Tropical storm activity in the eastern Pacific United States was much lower than average with only three hurricanes, of which only one, Hurricane Genevieve, moved northward along the Baja coast. The high-pressure ridge that typically pulls moisture from Mexico and the Gulf of California into Arizona was either too far south or too far west to bring us the moisture and instability needed for a wet monsoon. As a result, very little tropical moisture was pulled into the monsoon circulation.

2.C. CUMULATIVE PRECIPITATION AND STREAMFLOW SUMMARY

CUMULATIVE PRECIPITATION

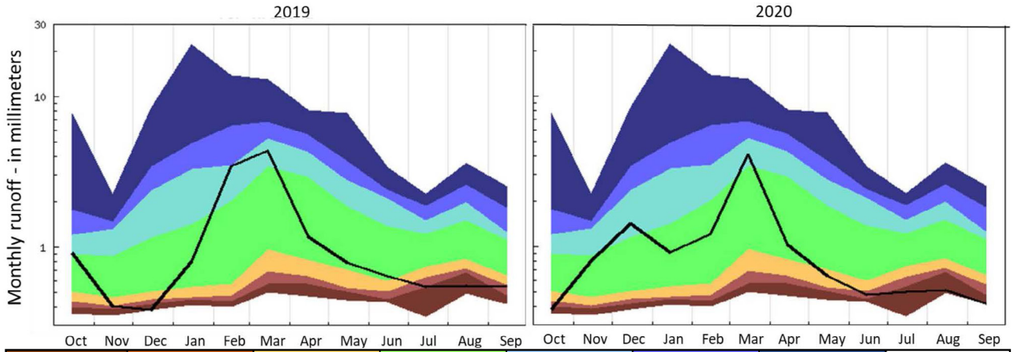
Cumulative precipitation for Water Year 2020 ended up at well below normal levels throughout the mountainous areas of Arizona, ranging from 60% to 83% of average in the major river basins. A lack of precipitation in the late winter months, as well as a weak monsoon season, contributed to the well below normal conditions for the water year **Table 1**.

TABLE 1. Water Year 2020 Mountain Precipitation (as of September 30, 2020)

Major Basin	Percent of 30-year Average Precipitation
Salt River Basin	60%
Verde River Basin	83%
San Francisco-Upper Gila River Basin	74%
Little Colorado River Basin	69%

STREAMFLOW

Drought status, as indicated by streamflow data **(Fig. 5)**. shows similar drought severity throughout Arizona from Water Years 2019 to 2020, though streamflow was different in certain times of the year. Streamflow data collected in 2020 shows significantly less runoff in October followed by increased runoff in November and December, compared to 2019. Both 2019 and 2020 runoff was in the normal to above normal range from January through April. However, more runoff was produced during May through September 2019 than during the same period in 2020. While the lack of summer monsoon storms affected both water years, 2020 was more negatively affected regarding runoff.



Lowest-5th percentile	6-9	10-24	25-75	76-90	91-94	Highest-95th percent	Runoff
Severe hydrologic drought hydrologicdrought	Moderate hydrologic drought	Below normal	Normal	Above normal	Much above normal		

Explanation - Percentile Classes Source: USGS WaterWatch

Figure 5. Area-based monthly runoff as determined by United States Geological Survey (USGS) streamflow gages for 2019 and 2020 representing the entire state of Arizona. The hydrograph (black line) represents runoff per unit area and is plotted over the long-term statistics of runoff for each month. The statistics, based on quality assured and approved data for the period of record, include the maximum runoff during the period of record for each month. The statistics, based on quality assured and approved data for the period of record, include the maximum runoff during the period of record for each month of the year (top of the dark blue area); the 90th percentile runoff for each month (top of the light blue area); the interquartile range (the green area bounded by the 75th percentile on top and 25th percentile on the bottom); the 10th percentile runoff for each month (the bottom of the orange area); and the minimum discharge for each month (bottom of dark brown area). The plot covers a period of one year with the statistics being identical for each year.

2.D. WATER SUPPLY STATUS

COLORADO RIVER BASIN AND RESERVOIR STATUS[1]

The Colorado River total system storage experienced a net decrease of 2.74 MAF in Water Year 2020. Reservoir storage in Lake Powell decreased by 1.87 MAF, and reservoir storage in Lake Mead increased by 0.014 MAF. At the beginning of the Water Year (October 1, 2019) Colorado River total system storage was 52% of capacity. At the end of the Water Year (September 30, 2020) total system storage was 47% of capacity.

[1]Information in this section was taken from the United States Bureau of Reclamation's Aug. 28 draft "Annual Operating Plan for Colorado River Reservoirs 2020." The information has been updated to the end of Water Year 2020, where appropriate and where data was available.

Precipitation in the Upper CRB was below average during Water Year 2020. On September 30, 2020, the cumulative precipitation received within the Upper CRB for Water Year 2020 was 23.5" or 76% of average. Snowpack conditions trended near average across most of the CRB throughout the snow accumulation season. The basin-wide snow water equivalent measured 107% of average on April 1, 2020, which is the same date the total seasonal accumulation peaked. On April 1, 2020, the snow water equivalents for the Green River, Upper Colorado River Headwaters, and San Juan River Basins were 110%, 115%, and 96% of average, respectively.

Unregulated[2] inflow into Lake Powell was 5.85 million-acre feet (MAF), or 54% of the 30-year average,[3] which is 10.83 MAF. Unregulated inflow to Flaming Gorge, Blue Mesa, and Navajo Reservoirs was 86%, 67%, and 51% of average, respectively. During the 2020 spring runoff period, inflows to Lake Powell peaked on June 5, 2020 at approximately 72,500 cubic feet per second (cfs). The April through July unregulated inflow volume for Lake Powell was 3.76 MAF, which was 52% of average.

Lower CRB tributary inflows above Lake Mead were below average for Water Year 2020. Tributary inflow measured at the Little Colorado River near Cameron gage totaled 0.091 MAF or 63% of average. Tributary inflow measured at the Virgin River at Littlefield gage totaled 0.12 MAF or 66% of average. Below Hoover Dam, tributary inflow for Water Year 2020 measured at the Bill Williams River below Alamo Dam gage totaled 0.083 MAF, and tributary inflow measured at the Gila River near Dome gage totaled 0.007 MAF.

SALT AND VERDE RESERVOIR

Water Year 2020 started with a wet November and December (7.83", 240% of normal) on the Salt and Verde watershed. As of January 1, 2020, the watershed received 125% to 200% of normal snowpack setting up conditions for a productive runoff season. Following a dry first half of the winter, the watershed then experienced the 12th wettest March on record (3.68", 194% of normal) and received 438,705 AF of inflow (243% of median). Overall, the watershed received a total inflow of 782,460 AF into Salt River Project (SRP) reservoirs (150% of median) throughout the entire winter runoff season (January – May) nearly filling reservoirs. Roosevelt Lake increased from 66% to 99% of capacity, from October 1 to May 1, coming just 17,000 AF short of filling the New Conservation Space (NCS) in April. Horseshoe and Bartlett Reservoirs on the Verde started the water year at a combined 54% full and were near 100% capacity by mid-March spilling approximately 30,000 AF of water over Granite Reef Dam throughout the month of March.

The 2020 monsoon season got off to another slow start with July and August receiving only 1.70" average watershed precipitation (37% of normal). With the exception of a small runoff event observed in late July, reservoir inflows remained minimal. August inflow of 10,262 AF (32% of median) was the lowest observed August inflow on record (dating back to 1913) and September has continued to remain dry. The 2020 monsoon season is projected to have both the lowest average precipitation (1.93", 30% of normal) and the lowest total reservoir inflow (32,354 AF, 30% of median) on record for the watershed. Despite the record dry monsoon across the watershed, the total storage of the Salt and Verde reservoir system remains at 82% (1,870,430 AF) as of September 30 compared to 69% at the same time last year. Total projected inflow for Water Year 2020 is approximately 1,059,000 AF (116% of median) making this the second water year in a row with above median inflow into the Salt and Verde reservoirs.

[2]Unregulated inflow adjusts for the effects of operations at upstream reservoirs. It is computed by adding the change in storage and the evaporation losses from upstream reservoirs to the observed inflow. Unregulated inflow is used because it provides an inflow time series that is not biased by upstream reservoir operations.

[3]All unregulated inflow, precipitation, and snowpack statistics are based on the 30-year period 1981-2010.

2.E. DROUGHT INDEX WELLS

ADWR maintains groundwater index wells throughout the state **(Fig. 6)**. Using criteria established by the USGS, six wells in Arizona have been utilized as qualitative supplements to existing drought indicators. Depth-to-water measurements are collected at these sites multiple times per day by means of a pressure transducer. Transducer measurements are later verified with less frequent discrete measurements taken by ADWR field staff. Additional information may be found on the USGS Climate Response Network website.

Figure 7 through 12 are hydrographs showing the groundwater level record and the historical daily median. Automated groundwater levels for each well site are plotted in blue, the historical daily median is plotted in green, and provisional data is plotted in red. The gray area on the right-hand side of the graph indicates the extent of Water Year 2020, beginning on October 1, 2019.

Location of Drought Watersheds and Index Wells

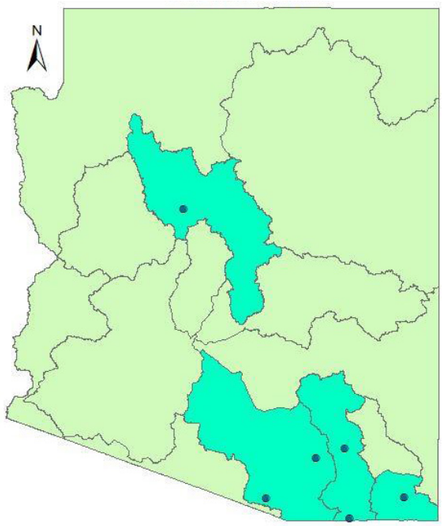


Figure 6. Arizona Department of Water Resources Drought Index Wells and Watershed Map

WHITEWATER DRAW WATERSHED - ADWR MONITORING SITE 'D-21-28 21BCB'

ADWR Index Well 'D-21-28 21BCB' is located within the Whitewater Draw Watershed and in the Willcox Groundwater Basin. Adjacent to the Leslie Creek drainage, this well is installed in shallow alluvial material.

With the exception of October 2019, there has been continued water level rise throughout the Water Year 2020. Observed water levels from mid-February 2020 have consistently remained above historical daily median values through the remainder of the water year.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 31° 35' 29.87", W 109° 30' 18.00"	25 feet	46-48 feet	18.34 feet	1.47 feet	10.98 feet

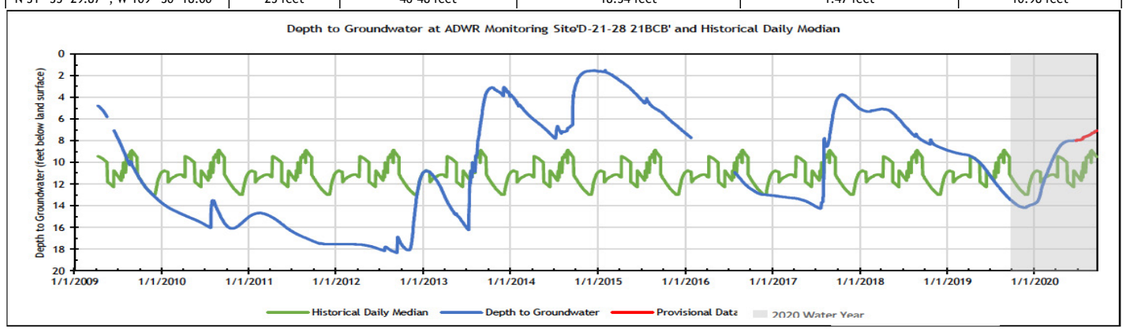


Figure 7. Automated groundwater level data for ADWR drought index well 'D-21-28 21BCB' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located here: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=313533109301801).

SAN PEDRO RIVER WATERSHED - ADWR MONITORING SITE 'D-15-20 09AAB2'

ADWR Index Well 'D-15-20 09AAB2' is located within the San Pedro River Watershed and in the Lower San Pedro Groundwater Basin. Situated on the bank of the San Pedro River, this well is completed in a shallow alluvial aquifer system and is in the river's floodplain.

Water levels at this monitoring site have consistently remained below the historical daily median throughout the water year with two exceptions. There were two precipitation events, one in December and another in March. With yet another dry monsoon over much of Arizona, this well has resulted in another record maximum depth to water of 34.81 feet on September 8, 2020. This surpasses the previous summer's record maximum depth of 34.53 feet.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 32° 09' 02.74", W 110° 17' 53.34"	89 feet	3307 feet	34.81 feet	26.10 feet	32.74 feet

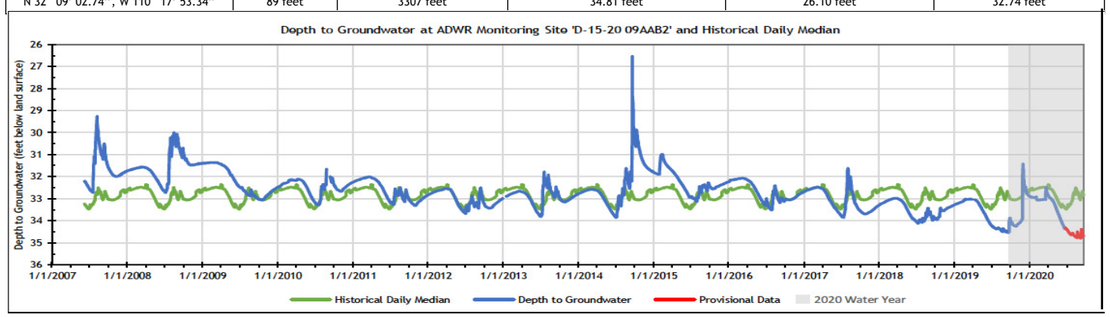


Figure 8. Automated groundwater level data for ADWR drought index well 'D-15-20 09AAB2' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located here: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=320901110175301).

SAN PEDRO RIVER WATERSHED - USGS MONITORING SITE 'D-24-21 17BCB3'

Monitoring well 'D-24-21 17BCB3' is operated through the USGS and is located to the southeast of the Huachuca Mountains in the San Pedro River Watershed. Consistent water level rise, up to 31.01 feet in April, was seen throughout most of the first half of the water year. This led to above average water levels in the winter and spring months. However, seasonal water level declines beginning in April have persisted through the summer, leaving water levels hovering near the historical daily median to end the 2020 Water Year.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 31° 20' 43.90", W 110° 14' 19.70"	123.6 feet	5100 feet	36.70 feet	30.05 feet	33.06 feet

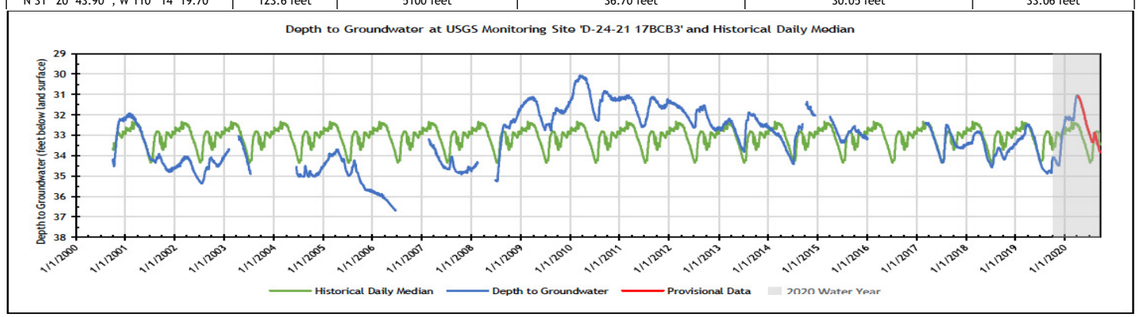


Figure 9. Automated groundwater level data for USGS drought index well 'D-24-21 17BCB3' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through the USGS Groundwater Watch web application, located here: https://groundwaterwatch.usgs.gov/NetMapT1L2.asp?ncd=crn&sc=04).

VERDE RIVER WATERSHED - ADWR MONITORING SITE 'B-17-02 26CCD3'

ADWR Index Well 'B-17-02 26CCD3' is located at Del Rio Springs in the Verde River Watershed. This monitoring well is completed in a shallow conglomerate unit.

Seasonal fluctuations continue to be observed, showing a consistent yearly rise in water level from Fall 2019 through Spring 2020 followed by a decrease in late Spring 2020 through the remainder of the 2020 Water Year. Water levels remained slightly below the historical daily median until July of 2020, at which point a continued decline resulted in levels well below historical averages. This site set another maximum depth to water record of 15.33 feet on September 8th, 2020, a decrease from the previous record of 15.09 feet set in 2019.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 34° 49' 11.86", W 112° 26' 40.83"	206 feet	4456 feet	15.33 feet	13.05 feet	13.94 feet

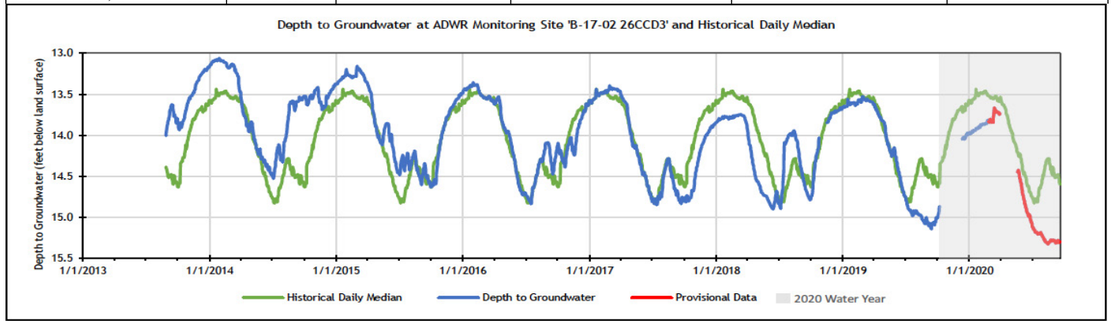


Figure 10. Automated groundwater level data for ADWR drought index well 'B-17-02 26CCD3' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located here: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=344912112264101).

SANTA CRUZ RIVER WATERSHED - ADWR MONITORING SITE 'D-16-16 14CAC'

ADWR Index Well 'D-16-16 14CAC' is located along Pantano Wash within the Santa Cruz River Watershed. This monitor well is completed in a shallow alluvial aquifer system.

For the data that is currently available, winter 2019-2020 precipitation events have kept water levels at or above historical daily median values throughout the 2020 water year despite a dry summer. Water levels ceased July 23rd, 2020 due to monitoring equipment issues and will soon be repaired.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 32° 02' 16.17", W 110° 40' 58.77"	105 feet	3179 feet	60.62 feet	26.01 feet	51.78 feet

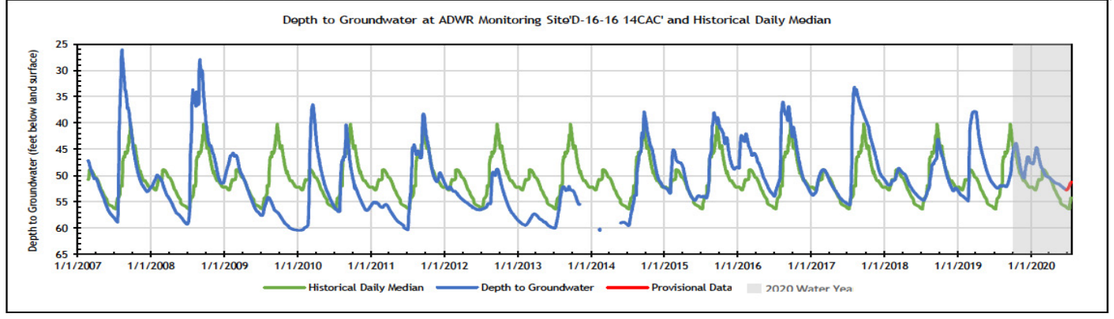


Figure 11. Automated groundwater level data for ADWR drought index well 'D-16-16 14CAC' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located here: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=320216110405901).

SANTA CRUZ RIVER WATERSHED - ADWR MONITORING SITE 'D-21-10 19DAD'

ADWR Index Well 'D-21-10 19DAD' is situated at the confluence of Fraguita Wash and Arivaca Creek in the Santa Cruz River Watershed. This well is believed to be completed in shallow alluvial materials associated with the drainages.

Water levels were well below historical daily median values during the beginning of the 2020 Water Year due to minimal monsoon activity during the fall of 2019. However, water levels quickly recovered to above-average during December. Since January 2020, a steady water level decline has been observed, from 11.92 feet down to 26.88 feet in September.

Location (NAD 27)	Depth of Well	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water	Median Depth to Water
N 31° 35' 05.88", W 111° 21' 06.94"	31 feet	3577 feet	28.85 feet	10.61 feet	21.22 feet

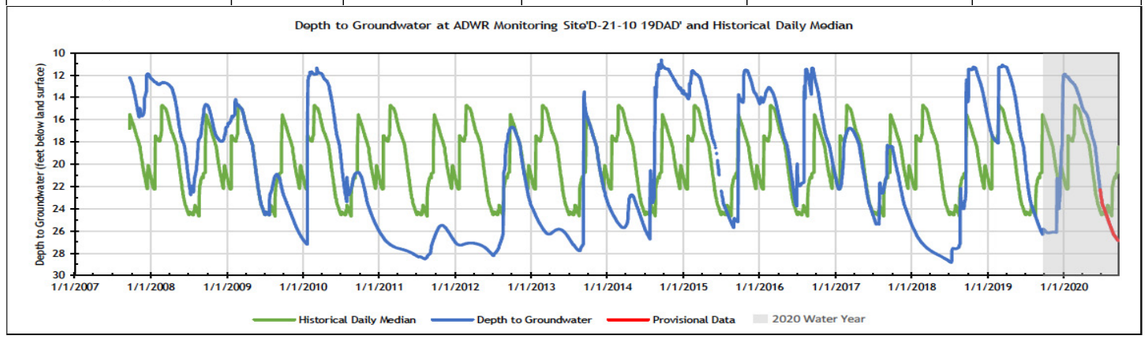


Figure 12. Automated groundwater level data for ADWR drought index well 'D-21-20 19DAD' plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located here: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=313506111210901).

ADWR DROUGHT INDEX WELLS

ADWR's Field Services Section collects groundwater levels statewide from approximately 1,800 index wells, including the state's six drought index wells. ADWR also maintains a statewide network of roughly 130 automated groundwater monitoring sites and an ORACLE database that contains field-verified data including discrete water level measurements, location, and other well specific information.

ADWR staff developed a Monitoring Well Network Optimization Plan in 2015, which in part focuses on the identification of additional drought monitoring index wells within the state. Water level data from continuous monitoring sites statewide are being reviewed and evaluated with respect to meeting criteria for the USGS Climate Response Network.

2.F. FOREST HEALTH AND DROUGHT

In times of significant drought, trees become increasingly stressed, which makes them even more susceptible to insect and disease infestation. Once tree mortality occurs, the associated fire risk is altered.

Aerial and ground detection surveys for dead and dying trees have been conducted in Arizona for more than 50 years by the Arizona Department of Forestry and Fire Management (DFFM) this survey data is used to monitor changes in forest health, as well as emerging insects and disease agents. This data and information are then provided to land managers and the public through the DFFM's annual Forest Health Conditions Report.

Because the state experienced a fairly wet winter and early spring this Water Year, there was an observed reduction in tree mortality caused by bark beetles in the following summer.

2.G. DROUGHT DECLARATIONS

A Drought Emergency Declaration has been in effect in Arizona since 1999. The current declaration, PCA 99006, was issued by the Governor in June 1999 and continued by EO 2007-10. The declaration maintains the state's ability to provide emergency response if needed and enables farmers and ranchers to obtain funding assistance through the Farm Service Agency (FSA) if they experience significant production losses due to drought.

The ICG is responsible for providing recommendations to the Governor regarding drought declarations based on presentations and discussions at the spring and fall ICG meetings **(see 3.B)**.

2.H. DISASTER DESIGNATIONS

A disaster designation from the Secretary of the U.S. Department of Agriculture (USDA) is necessary for farm operators in both primary and contiguous disaster areas to be considered for assistance from the FSA.

The USDA uses the U.S. Drought Monitor to help determine designations. Extreme Drought (D3) or Exceptional Drought (D4) qualify as automatic designations, while Severe Drought (D2) for eight consecutive weeks during the growing season qualifies for nearly automatic designation. This "Fast Track" authority designation process delivers fast and flexible assistance to farmers and ranchers. The disaster designations by the USDA in **Table 2** occurred this Water Year.

Table 2. Drought Disaster Designations in 2020

Date of Designations	Primary Disaster Counties	Contiguous Disaster Counties
March 7, 2020	Archuleta, Baca, Conejos, Costilla, La Plata, Montezuma, Las Animas (New Mexico)	Apache
March 7, 2020	Apache, Coconino, Navajo	Gila, Graham, Yavapai, Greenlee, Mohave
March 7, 2020	San Bernardino (California)	La Paz, Mohave
March 7, 2020	Kane, San Juan (Utah)	Apache, Coconino, Mohave, Navajo
March 7, 2020	Alamosa, Archuleta, Baca, Conejos, Costilla, Delta, Dolores, Garfield, Gunnison, Huerfano, La Plata, Las Animas, Mesa, Montezuma, Montrose, Ouray, Pitkin, Rio Blanco, Rio Grande, Saguache, San Miguel (Colorado)	Apache
August 21, 2020	Mohave	Coconino, La Paz, Yavapai
August 24, 2020	Church, Pershing (Colorado), Lincoln, Lyon	Mohave
August 24, 2020	Iron, Washington (Utah)	Mohave
September 4, 2020	Clark (Nevada)	Mohave
September 4, 2020	Catron, Hidalgo (New Mexico), Cibola, Luna, Grant, Santa Fe	Apache, Cochise, Greenlee
September 4, 2020	Cochise, Greenlee, Pinal, Gila, Maricopa, Yavapai, Graham, Pima	Apache, Mohave, Yuma, Coconino, Navajo, La Paz, Santa Cruz

2.I. DROUGHT STATUS CHANGES

Arizona's drought status is continually monitored and updated. The short-term drought status is updated weekly and monthly. The long-term drought status is updated seasonally at the end of each quarter.

The graph of Standardized Precipitation Index (SPI) for Arizona from 1 to 60 months **(Fig. 13)** shows short- and long-term drought conditions from January 1981 through September 2020. This is our second consecutive year of wet winter followed by a dry monsoon. This is the driest monsoon on record for most of the state. Currently the winter of 2020-2021 is forecasted to be drier than average, thus drought conditions are not anticipated to improve in the near future.

For more information about how the graph can be used to correlate precipitation and drought impacts, visit the University of Arizona Climate Science Application Program website.

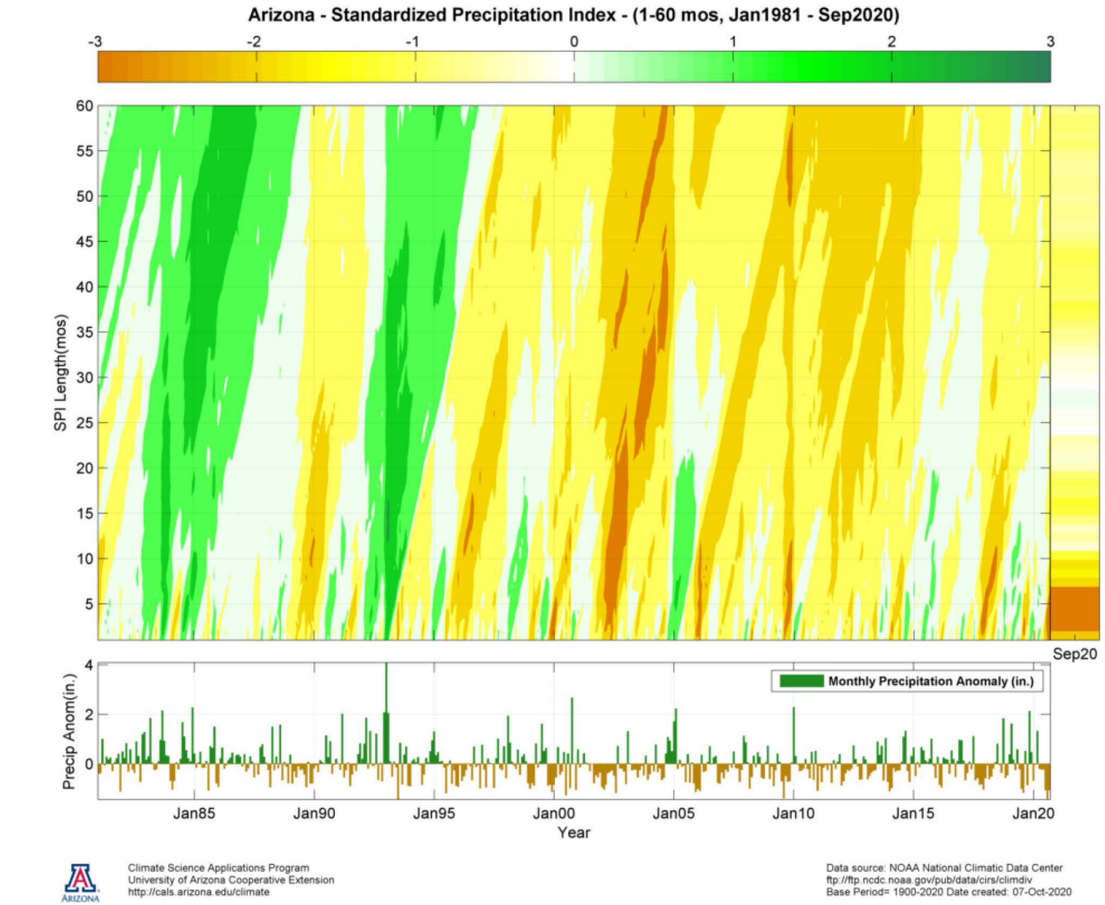


Figure 13. Standardized precipitation index and precipitation anomalies.

SHORT-TERM DROUGHT STATUS

After the dry 2019 monsoon season, Water Year 2020 began with most of the state (81%) in Moderate (D1) or Severe Drought (D2) conditions (Fig. 14). While October 2019 was very dry, November and December were extremely wet across Arizona. January 2020 was also dry, but February and March brought more rain and snow, eliminating short-term drought across most of the state **(**81%; **Fig. 15)**. However, for the second winter in a row, winter storms skipped northeastern Coconino and northern Navajo and Apache counties, leaving them in Moderate or Severe Drought.

Spring brought a few light showers, but by July, Abnormally Dry (D0) conditions were noted in Graham, Greenlee, Gila, and Pinal counties. Dry thunderstorms led to lightning caused wildfires that continued through the dry summer. During July and August, short-term drought conditions continued to deteriorate, and September was almost totally dry everywhere except Cochise and Santa Cruz counties. By the end of Water Year 2020, 100% of the state was in some level of drought, with 94% in Severe (D2), Extreme (D3) or Exceptional Drought **(**D4; **Fig. 16)**.

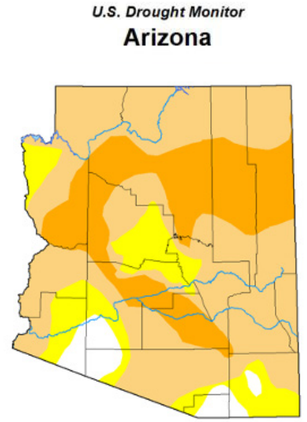


Figure 14. Oct. 1, 2019
Short-term Drought Status Map.

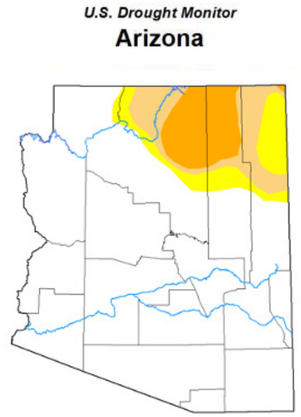


Figure 15. April 28, 2020
Short-term Drought Status Map.

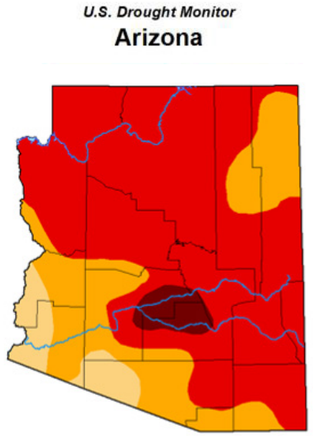


Figure 16. Sept. 29, 2020
Short-term Drought Status Map.

Table 3. Percentage of Arizona in Each Drought Category (Short-Term)

Category	Oct. 1, 2019	Apr. 28, 2020	Sep. 29, 2020
No Drought	5	81	0
D0 – Abnormally Dry	14	6	0
D1 – Moderate Drought	55	7	6
D2 – Severe Drought	26	7	24
D3 – Extreme Drought	0	0	67
D4 – Exceptional Drought	0	0	3

LONG-TERM DROUGHT STATUS

Long-term drought covers the previous 24-, 36-, and 48-month periods and incorporates the Standardized Precipitation-Evaporation Index (SPEI), since drought depends not only on precipitation but also on evaporation, which is largely dependent on temperature and wind in arid regions. Water Year 2020 began with Extreme Drought (D3) on the northeast Colorado Plateau and in the White Mountains of eastern Arizona, following a wet winter and a dry summer, both of which bypassed the northeastern quarter of the state **(Fig. 17a)**. The wet winter of 2019-2020 contributed to increased water supply across most of the state but was not as effective in the northeast as in other areas **(Fig. 17b)**. The dry and extremely hot summer reversed much of the improvements gained over the winter. Extreme Drought (D3) expanded in the northeast and the east central mountains and was introduced into central Arizona **(Fig. 17c)**.

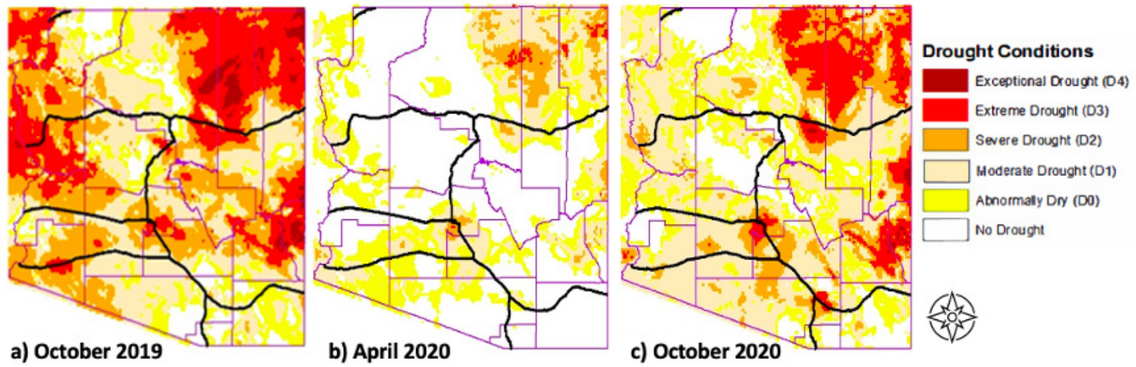


Figure 17. Quarterly SPEI Long-term Maps

2.J. OUTLOOK FOR WATER YEAR 2020-2021

WINTER 2020-2021

Tropical Pacific Ocean temperatures have cooled substantially since the summer, with a La Niña pattern already being observed in the ocean and atmosphere. These La Niña conditions should prevail through the winter of 2020-2021, potentially reaching a moderate stage before weakening in the spring. While other forcing mechanisms can influence the weather in Arizona in shorter time scales, in the seasonal scale, the majority of La Niña events result in drier than normal winters. In fact, many of the driest winters **(Fig. 18)** and worst snow seasons have been observed during La Niña conditions. In 14 observed La Niña winters since 1980, only one year has experienced above normal precipitation, while 4 years had near normal and 9 years of below normal precipitation.

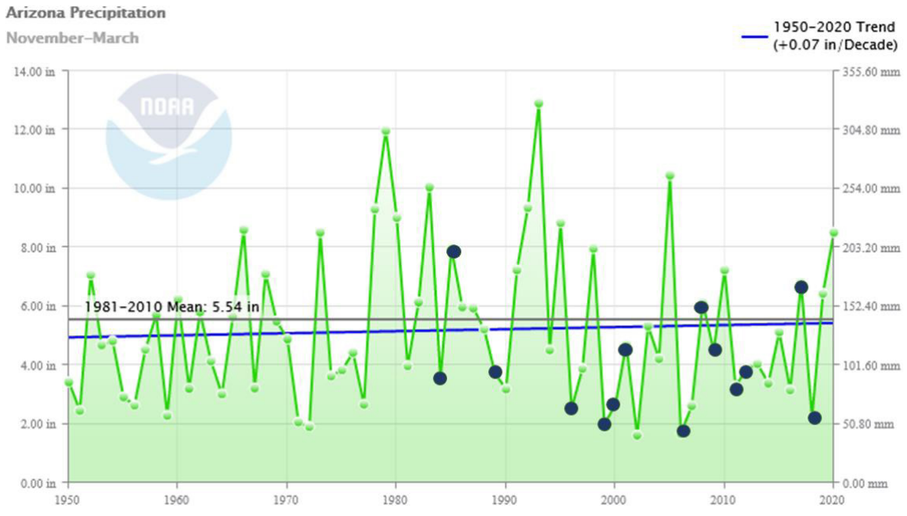


Figure 18. Historical Nov-Mar precipitation in Arizona since 1950. Blue dots are La Niña winters since 1980.

According to the official outlooks from National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Center **(Fig. 19)** for January–March 2021, the average temperature will likely fall in the near to above normal range. This is primarily supported by changing climate and the fact that Arizona winters over the past 10 to 20 years have steadily been warming. According to the precipitation outlook, winter totals favor the below normal category. This is based on a consensus of dynamic climate models along with historical precedent during La Niña winters as presented above.

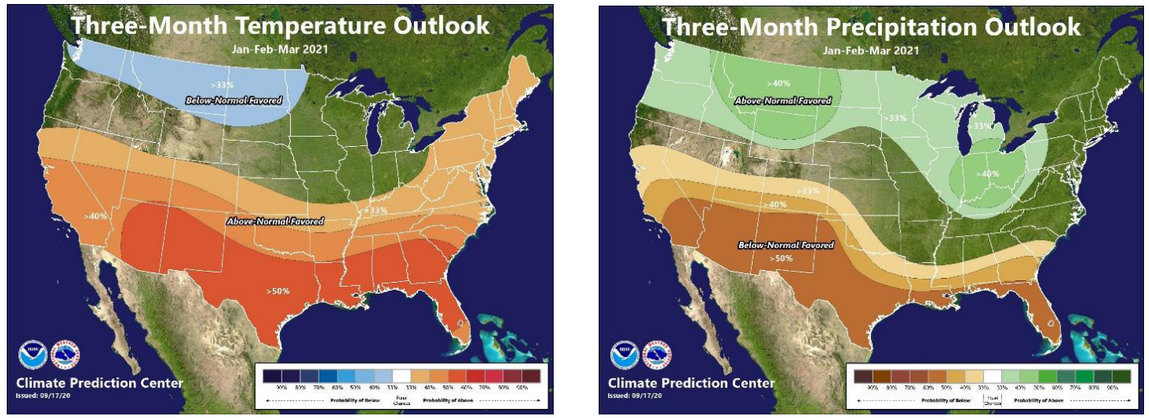


Figure 19. Climate Prediction Center outlook for temperature (left) and precipitation (right) for January–March 2021. Shading indicates the tilt in odds towards being above or below normal. Unshaded areas indicate equal chances of above, below, or near normal temperatures and precipitation.

SUMMER 2021

According to the Climate Prediction Center's outlook for July–September 2021 **(Fig. 20)**, the average temperature during summer 2021 will likely fall in the near to above normal range. This outlook is based strongly on trends of regional climate warming over the past 10 to 20 years versus the longer term 30-year average. The precipitation outlook shows no discernible signal during this period over Arizona. That is, there are equal chances for the 2021 monsoon season having above, below, or near normal rainfall. This is very common for the monsoon season where thunderstorm activity is usually localized and not influenced by larger scale climate signals.

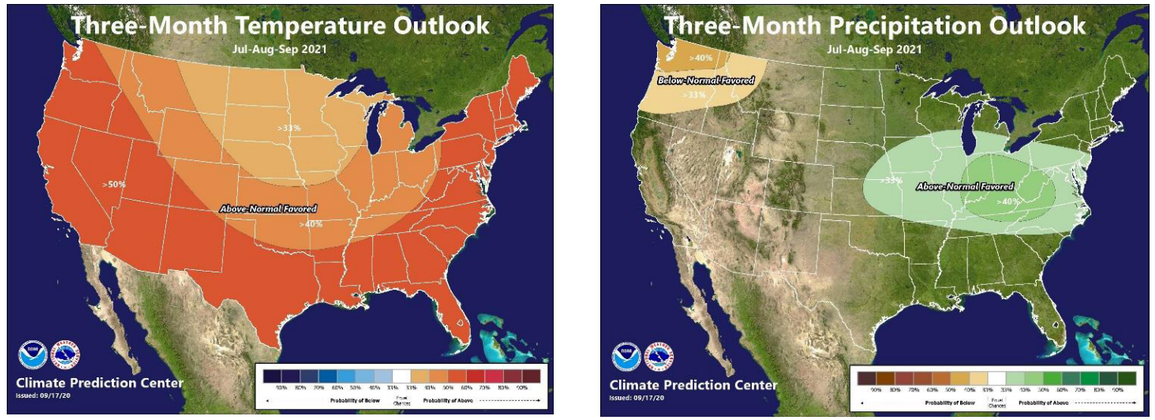


Figure 20. Climate Prediction Center outlook for temperature (left) and precipitation (right) for July–September 2021. Shading indicates the tilt in odds towards being above or below normal. Unshaded areas indicate equal chances of above, below, or near normal temperature and precipitation.

3. DROUGHT PREPAREDNESS PLAN IMPLEMENTATION HIGHLIGHTS

3.A. STATE MONITORING TECHNICAL COMMITTEE EFFORTS

The MTC is responsible for gathering drought, climate, and weather data, and disseminating that information to water and land managers, policymakers, and the public. Specifically, the MTC prepares the short- and long-term drought status reports, briefs the ICG on drought conditions, and provides assistance to LDIGs. The MTC is currently working on incorporating the streamflow data into the gridded long-term drought status maps. The two co-chairs are Dr. Nancy Selover, State Climatologist, and Mark O'Malley, National Weather Service.

COMMUNICATING DROUGHT STATUS

The MTC and ADWR coordinate to achieve the primary goal of improving the accessibility of drought information to resource managers, State decision-makers, and the public. To further communication, information is updated on the ADWR Drought Status webpage on a weekly, monthly, and quarterly basis as follows:

Weekly - The MTC confers weekly with the National Weather Service offices that cover Arizona; Flood Control Districts; LDIGs; water and rangeland managers; agricultural extension offices; and others who observe and report drought impacts. This is done to advise the U.S. Drought Monitor authors on the State's current drought conditions and provide recommendations on the drought boundaries for Arizona. The U.S. Drought Monitor is the official record of drought for federal drought relief claims. Information used by the MTC in advising the Drought Monitor authors includes numerous drought indices, precipitation and streamflow data, and impacts data. Every Thursday, ADWR's Drought Status webpage automatically updates with the latest U.S. Drought Monitor map of Arizona.

Monthly - At the end of each month, the MTC produces a web-based, short-term drought status update based on the U.S. Drought Monitor's maps for the past four weeks, with an explanation of how drought conditions have changed in Arizona over the preceding month. An email with the latest map and summary is sent to interested parties.

Quarterly - The MTC meets on a quarterly basis and produces a long-term drought status map and summary report using watershed precipitation averages to calculate the SPI and SPEI. This report incorporates the 24, 36, and 48-month precipitation and evaporation. Vegetation indices, snowpack, temperature, reservoir levels, and county-scale drought impact information are used to verify or modify the result of the calculations. The long-term drought status reports are posted on the ADWR website and disseminated via email seasonally: in April (for January – March); July (for April – June); October (for July – September); and January (for October – December).

ARIZONA DROUGHTVIEW

DroughtView, a University of Arizona program, is an online tool for collecting drought impact data that incorporates several remote sensing and climate drought monitoring products. The tool can be used to track high-resolution (~250 meters) changes in remotely sensed 'greenness,' using Normalized Differenced Vegetation Index data collected on a bi-weekly basis from the National Aeronautical and Space Administration's (NASA) Moderate Resolution Imaging Spectroradiometer (MODIS) satellite. This index can be particularly useful for tracking changes in rangeland conditions related to livestock forage production and forest drought stress, which can indicate longer-term drought impacts and wildfire risk. For more information, visit the University of Arizona DroughtView website.

COMMUNITY COLLABORATIVE RAIN, HAIL, AND SNOW (CoCoRaHS) NETWORK

The CoCoRaHS network of citizen precipitation observers in Arizona continues to expand. There is a new drought impact reporting tool called "Condition Monitoring," where some of the 1,544 observers in Arizona are adding weekly observations of the condition of vegetation, water bodies, and wildlife that reflect drought impacts. Since the observers simply note the conditions they observe every week, they do not require extensive training to provide useful information. In addition to the drought reports, the CoCoRaHS precipitation reports are incorporated into the precipitation products used by the Drought Monitor authors and by the Parameter elevation Regression on Independent Slopes Model (PRISM) group who generate the gridded SPI and SPEI data for our long-term maps.

DROUGHT DETECTION FOR RANCH-SCALE TOOLS

Drought creates both production and legal risks to ranches as they typically rely on federal lands for 50%-90% of their forage and policies for these rangelands dictate responses regarding herd reduction, reduced access to forage, and a lengthy approval process to change infrastructure and management. The patchy spatial distribution of drought in Arizona means that some ranches experience drought while others do not. However, the spatial resolution of drought information is too coarse to represent this difference among ranches.

Mike Crimmins, an MTC Member, and his team held three workshops and developed two online tools to support the deployment of rain gauges for ranchers and federal managers in Arizona to more precisely detect drought at the ranch-scale. Workshop participants indicated these new precipitation monitoring tools will help reduce production and legal risk by focusing responses only on drought-affected ranches.

GRASSLAND PRODUCTIVITY FORECAST

An innovative Grassland Productivity Forecast known as "Grass-Cast" was released for the Southwest in Spring 2020. Grass-Cast is an optional tool that managers can use to develop well-informed expectations about grassland productivity. The model provides three "what-if" scenarios that show how much grass might grow during the upcoming season depending on whether precipitation is above, near, or below-normal. Grass-Cast can be used in the design of proactive drought management plans, trigger dates, stocking dates, and grazing rotations.

Grass-Cast is the result of a collaboration between the USDA Research Service, the USDA's "Climate Hubs", and Natural Resources Conservation Service. Visit the Grass-Cast website.

DROUGHT IMPACT REPORTS FROM STATE AND FEDERAL AGENCIES

Drought impact data is used by the MTC in its efforts to correlate on-the-ground drought conditions with precipitation and streamflow data. Impact information is received from hydrologists, researchers, and other field staff from the Bureau of Land Management, USGS, USDA Natural Resources Conservation Services (NRCS), Arizona Department of Forestry and Fire Management, Arizona Game and Fish Department, Arizona State Parks, Native American Communities and other state and federal groups.

The NRCS submits a water year report **(Appendix A)**, which identifies the impacts of drought on range and farmland. The 2020 survey sent to all NRCS field offices in the state collected drought impacts on dryland farming, irrigation water supply, rangeland water supply, rangeland forage supply, and rangeland precipitation. Losses of crop production, shortages of water supply, and shortages of forage were reported.

MTC PRESENTATIONS AND WORKSHOPS

ARIZONA DEPARTMENT OF HEALTH SERVICES ANNUAL SANITARIANS CONFERENCE, PHOENIX, AZ, NOVEMBER 6-7, 2019

MTC Co-chair, Dr. Nancy Selover. presented on Arizona's climate and health, including health impacts of drought.

DROUGHT LEARNING NETWORK MEETING: LAS CRUCES, NM, FEBRUARY 11-12, 2020

Dr. Nancy Selover participated in this meeting to discuss how to expand drought communication, including reporting impacts and mitigation, to local stakeholders and groups across the southwest using lessons learned in Arizona. The meeting was hosted by the USDA Southwest Climate Hub and New Mexico State University. Five working group sub-committees were developed to address various drought issues including Tribal issues, new farmers, case studies, water in Utah, and moving from projections of drought to implementing responses.

SOUTHWEST DROUGHT AND HEALTH WORKSHOP, TUCSON, AZ, FEBRUARY 26-27, 2020

MTC members Dr. Nancy Selover, Carlee McClellan, Kathy Chavez, Matthew Roach, and Némesis Ortiz-Declet, participated in the workshop. Nancy Selover introduced to drought in the southwest for the Healthy Community presentation. Carlee McClellan presented on satellite-based drought reporting on the Navajo Nation. Kathy Chavez presented on Pima County drought preparedness. Matthew Roach provided an overview of drought and health work done by the Arizona Department of Health Services. Additionally, drought impacts on air quality, water quality, and food security were discussed. The workshop helped identify gaps and needs, collaborative opportunities, and ways to integrate the health sector into drought planning, it was a product between NIDIS and the University of Nebraska Medical Center College of Public Health.

SOUTHERN ARIZONA DUST STORM WORKSHOP, COOLIDGE, AZ, MARCH 3, 2020

ADHS representatives participated in the workshop hosted by the Arizona Department of Transportation, Arizona Department of Environmental Quality and the NOAA National Weather Service offices in Tucson and Phoenix. The event brought together a wide and diverse group of vested partners for the 9th annual Arizona Dust Workshop. This workshop provided an opportunity to evaluate and discuss recent successes, while also developing future endeavors and goals. The workshop was designed to strengthen existing relationships and develop new relationships to mitigate the dust problem.

DROUGHT LEARNING NETWORK VIRTUAL QUARTERLY MEETING, APRIL 29, 2020

Dr. Nancy Selover (MTC) participated in this meeting, which included an in-depth update on the activities of the Case Studies Work Group and brief updates from the other work groups.

WATER AT THE CROSSROADS: THE NEXT 40 YEARS, UNIVERSITY OF ARIZONA WATER RESOURCES RESEARCH CENTER 2021 ANNUAL CONFERENCE JUNE 18-19, 2020

MTC members, Dr. Nancy Selover and Némesis Ortiz-Declet, attended the virtual meeting to hear the plans for Arizona's next 40 years of water planning.

DROUGHT LEARNING NETWORK VIRTUAL QUARTERLY MEETING, AUGUST 5, 2020

Dr. Nancy Selover (MTC) presented on drought in the West during this meeting, which included an in-depth update on the activities of the New Farmer s and Ranchers Work Group and brief updates from the other work groups.

ARIZONA WATER LAW CONFERENCE, AUGUST 13-14, 2020

Dr. Nancy Selover (MTC) presented on Climate Change and Water in Arizona to attorneys involved in Water Law and Adjudication, hosted by CLE International.

3.B. INTERAGENCY COORDINATING GROUP EFFORTS

The ICG has met biannually since 2006 and advises the Governor on drought status, impacts, and any necessary preparedness and response actions.

The 2019 Fall meeting included a review of 2019 drought status, winter 2019-2020 weather outlook, 2019 wildfire season update, 2019 forest and woodland health, and water supplies updates for the Colorado River, Salt River and Verde River watersheds.

The Spring 2020 meeting included a review of 2019-2020 winter precipitation, Summer 2020 and winter 2020-2021 weather outlook, 2020 forest health review, and water supply updates for the Colorado River, Salt River and Verde River Watersheds.

At both the Fall 2019 meeting and Spring 2020 meeting, the ICG recommended continuation of the Drought Declaration (Executive Order 2007-10) and the Drought Emergency Declaration (PCA 99006) for the State of Arizona.

The presentations and subsequent decisions are on the ADWR ICG webpage.

3.C. DROUGHT PLANNING FOR COMMUNITY WATER SYSTEMS

Drought planning requirements and water use reporting regulations for Community Water Systems (CWSs) were recommended in the 2004 Arizona Drought Preparedness Plan and established by the State Legislature in 2005 to help CWSs reduce their vulnerability to drought and water shortages. These reports provide a means for the State to gather water use data and offer assistance to CWSs that need it. ADWR provides assistance to water providers in meeting these requirements through web-based resources, online reporting tools and phone or in-person consultations. For more information, see ADWR Community Water System webpage.

All CWSs in the State are required to submit a Drought Preparedness Plan to ADWR every five years. The Drought Preparedness Plan is part of the required System Water Plan (SWP), which also includes a Water Supply Plan and a Conservation Plan. The Drought Plan requires water systems to describe their drought stages and triggers, emergency sources of water, customer communication strategies, and other planning actions. As of the end of Water Year 2020, ADWR has received SWPs from 827 or 91% of CWSs.

The number of annual water use reports received from active CWSs located outside the State's Active Management Areas (AMAs) can be seen in Table 4. Annual water reports have been required for systems inside the AMAs since the passage of the 1980 Groundwater Act.

3.D. LOCAL DROUGHT IMPACT GROUP EFFORTS

LDIGs participate in monitoring, education, and local mitigation, mainly through cooperative extension

Table 4. Annual Water Use Reports Received from Active CWSs Located Outside Active Management Areas

2019	2018	2017	2016	2015	2014	2013	2012	2011	2010
Number (and percent) of reports received out of total active CWSs for that year:									
396/471 (84%)	341/481 (71%)	369/465 (80%)	388/466 (83%)	389/465 (84%)	383/462 (83%)	382/468 (82%)	382/461 (83%)	394/461 (85%)	390/469 (83%)
Percent of non-AMA population represented by CWS reports received:									
92%	89%	90%	92%	96%	97%	96%	93%	97%	96%

and county emergency management programs. Initial planning efforts included 10 LDIGs and as many as eight LDIGs have been active in the past. Since 2008, in response to local fiscal and staffing limitations, LDIGs focus has been entirely on drought impact monitoring and reporting. Currently, Pima County has an active LDIG program and Mohave County had an Active LDIG until recently. See **Appendix B** for the Pima County LDIG Report and **Appendix C** for a Mohave County LDIG Report.

3.E. COLORADO RIVER DROUGHT PLANNING EFFORTS

The Colorado River is a highly variable system, subject to dramatic change in runoff from year to year. In general, the average annual natural flow of the Colorado River at Lee's Ferry has averaged around 15 MAF over a 113-year period (Water Years 1906 through 2018) but has ranged from as little as 5.4 MAF to as much as 24.4 MAF in a single year. Based on tree ring studies, the 16-year period starting in 2000 ranks as the fifth driest 16-year period in the last 1,200 years.

The all entire Colorado River System reservoirs have been declining and projections indicate that this may continue into the foreseeable future.

2007 INTERIM GUIDELINES

In December 2007, the Secretary of the U.S. Department of the Interior (Interior) adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (2007 Interim Guidelines). The 2007 Interim Guidelines created a novel approach to Colorado River operations that incentivized conservation and augmentation through the creation of Intentionally Created Surplus (ICS). In addition, the Guidelines defined the criteria for shortages in the Lower Basin based on elevations in Lake Mead, implemented closer coordination of operations of Lake Powell and Lake Mead, and preserved flexibility to deal with further challenges such as climate variability and deepening drought.

PILOT SYSTEM CONSERVATION PROGRAM (PSCP)

More recent drought mitigation planning efforts include the PSCP and the Lower Basin Drought Memorandum of Understanding (MOU) agreements. The PSCP involves water agencies from both the Upper and Lower Colorado River Basins that agreed to jointly fund water conservation projects in both the upper and lower basins to benefit the Colorado River system. The purpose of the Lower Basin Drought MOU was to generate additional water to be left in Lake Mead to reduce the risk of reaching critical reservoir elevations. Both programs were voluntary and were initiated in 2014. The Pilot Program in the Lower Basin is expected to create 175,347 AF of system conservation in Lake Mead by 2035 for a cost of approximately $29.8 million or $170.14/AF. The Federal/Non-Federal cost share is 47/53%, respectively. By the end of Calendar Year 2019, 94% of the system conservation created by the Pilot Program or 165,618 AF of system conservation are expected to be conserved in Lake Mead. Although the Pilot Program will be ongoing until 2035, as of 2019, future announcements of funding opportunities and requests for additional Pilot Program project proposals are not being contemplated.

DROUGHT CONTINGENCY PLAN (DCP)

In 2013, the seven Colorado River Basin States, the United States, and the Republic of Mexico started drought contingency planning discussion in response to the ongoing historic drought on the CRB.

Arizona's participation in this effort proceeded along two tracks: one was the intra-Arizona pursuit of a plan to implement the DCP within Arizona and to authorize the Director of ADWR to sign the DCP on behalf of the state. That effort became known as Arizona's DCP Implementation Plan. The other track involved the negotiations among the Colorado River Basin States and the Interior to finalize the DCPs.

The agreements include an Upper Colorado River Basin DCP and a Lower Colorado River Basin DCP (LBDCP). They are designed to help reduce the risk of Colorado River reservoirs, particularly Lake Powell and Lake Mead, declining to critical elevations. In Arizona, a new shortage tier, Tier 0, requires reductions of 192,000 AF when Lake Mead is below elevation 1,090 ft.

The LBDCP Agreement was made and entered on May 20, 2019, by and among the United States, represented by the Secretary of the Interior, the State of Arizona acting through the Director of the ADWR, the Metropolitan Water District of Southern California (Metropolitan), the Coachella Valley Water District (CVWD), the Palo Verde Irrigation District (PVID), the City of Needles, CA, the Colorado River Commission of Nevada (CRCN), and the Southern Nevada Water Authority (SNWA).

The LBDCP is designed to protect Lake Mead from declining to critically low elevations by requiring water delivery reductions at higher elevations than specified in the Interim Guidelines and providing enhanced incentives for conservation of water to be stored in Lake Mead by Arizona, California, and Nevada. Adoption of the LBDCP is important to Arizona, which is at risk of potentially catastrophic reductions in water deliveries if elevations in Lake Mead continue to fall to critically low elevations. To adopt and implement the LBDCP, Arizona established a Steering Committee, composed of key water leaders, water users, and representatives from various sectors across the state within Arizona in a way that is acceptable to Arizona water users.

Overall, Arizona's path to the final May 20, 2019, signing was more arduous and complex than that of other states. But, in the end, the very transparent process proved to be worthwhile. According to Governor Doug Ducey, it was "the most significant water legislation passed in nearly 40 years."

ARIZONA'S RECONSULTATION

On May 20, 2019, at a signing event atop of Hoover Dam, the long, difficult multi-state negotiation process over the DCP finally concluded. The success of that effort was due to the commitment and hard work of leaders in the water community and a public process focused on the perspectives of varied Arizona stakeholder interests.

Arizona continues to build on the success of the DCP process by utilizing the same approach to develop an Arizona consensus on the "reconsultation" of the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead, also known as the 2007 Guidelines.

On June 25, 2020, Arizona reconvened Arizona's Lower Basin Drought Contingency Plan Steering Committee delegates to form the Arizona Reconsultation Committee.

In all, the group set out four primary goals for itself:

- Establish a process for continued engagement within Arizona throughout the Reconsultation process
- Provide a venue for developing and sharing stakeholder perspectives and values to guide Arizona's perspectives in the Reconsultation process
- Identify risks and benefits to inform Arizona's input to the Reconsultation process
- Continue the transparency that was established during the successful DCP Steering Committee effort

Overall, this process will take many years and require multiple levels of discussion, negotiation and coordination within Arizona and among the Colorado River Basin states.

3.F. ARIZONA WATER INITIATIVE ACTIVITIES

The Arizona Water Initiative was originally formed by Governor Ducey in October 2015 to implement the Arizona Strategic Vision for Water Supply Sustainability. The Water Initiative was expanded through the creation of a new Governor's Water Augmentation, Innovation and Conservation Council (GWAICC; Council) in January 2019, per Executive Order 2019-02.

The Council is charged with identifying and recommending opportunities for water augmentation, innovation, and conservation. The Council is also tasked with providing guidance on issues to the Director of ADWR upon the Director's request. The Council brings together stakeholders from across the state to raise, analyze, discuss, and vet what are often difficult, complex issues in an effort to ensure a sustainable water future.

The Council is currently composed of 43 individuals appointed by the Governor. They come from diverse organizations and backgrounds, including local and state government, Tribal communities, non-profits, business associations, academia, public and private water providers, and Arizona agriculture, mining, and homebuilding. The Council is chaired by the Director of ADWR.

Over the course of Water Year 2020, the Council was informed regarding ADWR's ongoing work to complete and promulgate the AMAs Fourth Management Plans and to develop the Fifth Management Plans. At the Chairman's request, the Council provided feedback regarding two potential options to complete the remaining Fourth Management Plans for the Phoenix, Pinal, and Santa Cruz AMAs, largely supporting the inclusion of incremental increases in conservation requirements in the plans. The Council was apprised of the Pinal AMA Assured Water Supply physical availability issues and the stakeholder process. The Director informed the Council regarding the Lake Powell Pipeline and the newly formed Arizona Reconsultation Committee. The Council requested and was provided information on the progress toward safe-yield in the AMAs, as well as the challenges of analyzing that progress. In response to a request by Council members, the Chair enabled discussion of tribal water rights and water rights settlements. This began with a background presentation by ADWR at the March Council meeting, followed by a special meeting in September at which tribes shared their perspectives with the Council.

Based on a recommendation of the Council to assist providers in addressing distribution system water loss, ADWR, in partnership with the Water Infrastructure Finance Authority, implemented a two-phased Water Loss Control Technical Assistance Program (TAP) pilot for small and mid-sized utilities that was completed in Water Year 2019. In 2020, ADWR, using the Water Management Assistance Program, began funding another pilot TAP through the Arizona Municipal Water Users Association that is providing more advanced technical assistance and training to nine of the state's largest water providers. The experience gained in the third pilot effort will build on what was achieved in the prior two phases.

COMMITTEES OF THE COUNCIL

The Council may form working groups or committees. There are currently four committees, which work to identify and discuss issues and develop, evaluate and prioritize recommendations for the Council to consider. Participation in the committee meetings is open to the public. Committees meet three to six times a year.

LONG-TERM WATER AUGMENTATION COMMITTEE

Purpose: To identify and explore methods of augmenting water supplies in Arizona.

Through the course of Water Year 2020, the committee explored additional options for augmentation—weather modification, forest management, and phreatophyte management—and considered what research may be needed and how viable these strategies may be as means to augment water supply in Arizona. In September, the committee provided information to the Council on the importance of watershed management to Arizona's water supplies, as well as the viability of snowpack augmentation and the need for research into the potential benefits within Arizona specifically. A technical working group of the committee was formed in January 2020 to recommend site selection criteria for a possible revision of the 2017 Potential Water Storage Sites on State Trust Land report.

DESALINATION COMMITTEE

Purpose: To evaluate and overcome barriers to desalination projects and identify opportunities to assist in developing potential projects.

In Water Year 2020, the committee largely focused on the exploration and discussion of the challenges and opportunities involved in the use and desalination of brackish groundwater. The committee explored existing desalination projects, cutting edge desalination technologies, and alternatives for brine disposal and has expressed interest in investigating innovative financing strategies for projects. The committee considered information on the Yuma Desalting Plant and the benefits to central Arizona's Colorado River supply from operation of the plant. At the committee's request, ADWR staff compiled a brief overview of permitting requirements for waste brine disposal for stakeholders. The committee formed a Desalination Regulatory & Legal Subcommittee to further explore issues that could impact potential desalination projects in select areas.

NON-AMA GROUNDWATER COMMITTEE

Purpose: To address groundwater issues outside of AMAs.

Committee participants identified issues and concerns relating to groundwater use as topics for discussion, narrowing the list to four categories: groundwater management strategies, data needs, best management practices and education, and well monitoring or measuring and reporting. Over the course of Calendar Year 2020, meetings have been largely informational in nature, allowing committee participants to gain understanding of the status of groundwater supplies outside the AMAs, the data available, and the data gaps that exist. In the coming calendar year, the committee will be taking on the topic of Irrigation Non-Expansion Areas, or INAs, as they begin to explore potential groundwater management strategies.

POST-2025 AMAs COMMITTEE

Purpose: To identify challenges within Arizona's AMAs and generating strategies and solutions beyond 2025.

The committee began the work of identifying challenges to groundwater management in the AMAs in October of 2019 and will continue the process of issue identification and analysis throughout 2020. The committee plans to have a consensus-based list of issues, each described in an issue brief, to bring to the Council for consideration and discussion at the December 2020 Council meeting. The committee has completed three issue briefs to date, addressing the topics of groundwater pumping, hydrologic disconnect, and exempt wells. Work on two additional issue briefs is underway, one addressing the Central Arizona Groundwater Replenishment District and the Assured Water Supply Program, and another on post-2025 AMAs regulatory structure. Once there is consensus around the issues and priorities, and there is support from the Council, work to develop the solutions will begin in 2021.

3.G. DROUGHT AND HEALTH EFFORTS

The Arizona Department of Health Services (ADHS), Office of Environmental Health addresses and monitors the public health effects of drought in Arizona. Issues related to drought that may lead to key public health concerns include water quality, air pollution, extreme heat, social vulnerability, and zoonotic diseases.

Arizona groundwater is known to contain arsenic, fluoride, and uranium, sometimes naturally occurring. Though, sometime naturally occurring drought can affect the level of the water table, which can then affect water quality due to the fluctuating concentration of the metals and minerals. Drought has been shown to also affect bacteria and nitrate concentrations in groundwater. The Arizona Environmental Public Health Tracking (EPHT) Data Explorer tracks the levels of these contaminants in drinking water from public drinking water systems and private wells throughout Arizona with data available from 2006-2019.[4] EPHT data shows there is variation of contaminant location throughout the state and of the depth of occurrence in the groundwater.

The health of vulnerable populations may be most affected by drought, including children, older adults, pregnant women, and low-income persons. In Arizona, the number of people of the age 65 and older has increased. Previously, this group made up 13.9% of the population in 2010 and increased to 17.5% in 2018.[5] Additionally, approximately 14.7% of the state's population were living in poverty, and 12.1% were living without health insurance in 2017.[6] Others that may affected by drought are families who need safe water to prepare infant formula, businesses that rely on water (such as farms, ranches, restaurants, and hair salons), people participating in outdoor water activities, and people who rely on water from private wells.[7]

Poor air quality can be the result of contributors such as wildfire smoke, vehicle emissions, and residential/industrial emissions.[8] Drought can affect air quality in several ways. For example, drought and heat waves can cause vegetation to dry up, which can then become fuel for wildfires leading to more smoke and an increase in health problems.[9] In addition, drought conditions can both intensify and increase the number of dust storms, which in turn reduces air quality. Dust storms are also a visibility hazard for motor vehicle accidents on roadways.[10] Several counties in Arizona, notably, Pinal and Maricopa counties, experienced 3.6% and 2.2% of days of particulate matter (PM) 2.5 levels and 10.4% and 4.7% of days of PM 10 levels above the National Ambient Air Quality Standards (NAAQS) in 2018, respectively.[4] Poor air quality can exacerbate chronic respiratory conditions such as asthma and chronic obstructive pulmonary disease. In 2018, the state age-adjusted rates for emergency care visits for these conditions were 37.5 and 37.4 per 10,000 population, respectively.[4]

Drought and extreme heat are intertwined. Unusually high temperatures and dry spells can contribute to drought severity. In addition, drought can exacerbate extreme heat effects. For example, extremely hot days during a drought can have detrimental effects on a population. The number of extreme heat days and nights are projected to increase in duration and frequency in the future. Extreme heat has a greater impact in the southern and western part of the state, and the health impacts on vulnerable populations are reflected in health outcome data tracked by ADHS. Over the last three years, heat-related deaths have increased, exceeding 250 deaths annually. In 2019, there were 2,944 heat-related illness emergency department visits and 283 heat-related deaths recorded in Arizona, occurring in predominantly Maricopa, Mohave, Pima, Pinal, and Yuma counties.[11]

[4] https://gis.azdhs.gov/ephtexplorer/
[5] https://ephtracking.cdc.gov/DataExplorer/#/
[6] https://www.cdc.gov/air/particulate_matter.html
[7] https://www.cdc.gov/nceh/hsb/cwh/docs/CDC_Drought_Resource_Guide-508.pdf
[8] https://www.ncdc.noaa.gov/news/impact-weather-and-climate-extremes-air-and-water-quality
[9] https://azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/index.php#news-publications
[10] https://azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/monsoon-safety/index.php#dust-storm
[11] http://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/valley-fever/reports/valley-fever-2018.pdf

Drought conditions can create an environment ripe for transmission of zoonotic diseases, including Valley fever and West Nile virus (WNV). Dust that is blown by dust storms throughout the year can carry the fungal spores, Coccidioides, which are the source of infection for coccidioidomycosis, also known as Valley fever. It is a fungus that is commonly found in Southwestern United States. People can acquire Valley fever by breathing in the microscopic fungal spores from the air, although most people who breathe in the spores don't get sick.[12] Symptoms are similar to the flu and include fatigue, cough, fever, shortness of breath, headache, night sweats, muscle aches, and rash. From 2009 to 2018, Valley fever incidence decreased from 155.1 to 105.7 per 100,000 population in Arizona.[13] Drought increases opportunity for WNV transmission by reducing the size of water bodies, causing them to become stagnant; this provides additional breeding grounds for certain types of mosquitoes.[14] WNV disease symptoms include acute febrile illness with headache, myalgia or arthralgia, and gastrointestinal issues. WNV disease is reported mostly from Maricopa, Pima and Pinal counties, where the majority of WNV cases occurred in 2019.[15]

ENVIRONMENTAL PUBLIC HEALTH TRACKING (EPHT) PROGRAM

Monitoring health status during moderate to severe drought years is feasible through the ADHS EPHT program **(Fig. 21)**. ADHS was awarded this grant through the Centers for Disease Control and Prevention (CDC) in 2017 for five years. Now in its fourth year, public health partners are able to access and track environmental and health indicators in one location at different spatial scales, such as county, sub-county, and community water system levels **(Fig. 22)**. Drought-related environmental topics tracked include drought indices, extreme precipitation, flood vulnerability, temperature, heat vulnerability, wildfires, hazard losses, water quality, and air quality. Drought-related health topics tracked include asthma, heat-related illness, chronic obstructive pulmonary disease (COPD) hospitalizations, heat-related deaths, WNV, and social vulnerability factors. Data is visualized in an online interactive Data Explorer in maps, tables, graphs, and charts can be viewed on the EPHT program website.

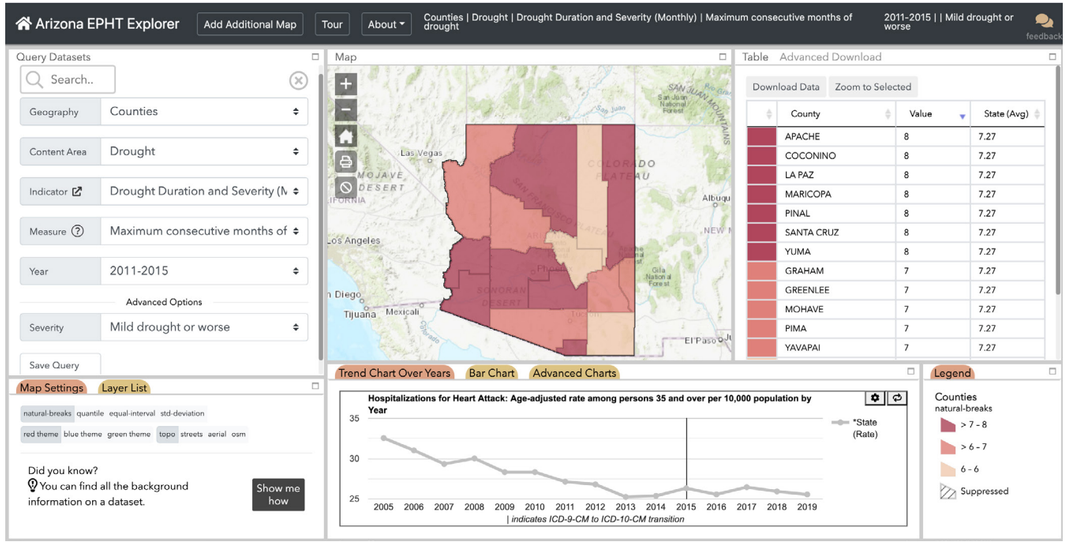


Figure 21. EPHT Program Website

[12] http://azdhs.gov/documents/preparedness/epidemiology-disease-control/extreme-weather/pubs/projections-climate-impacts-vector-borne.pdf
[13] https://www.cdc.gov/fungal/diseases/coccidioidomycosis/symptoms.html
[14] http://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/valley-fever/reports/valley-fever-2018.pdf
[15] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5310598/

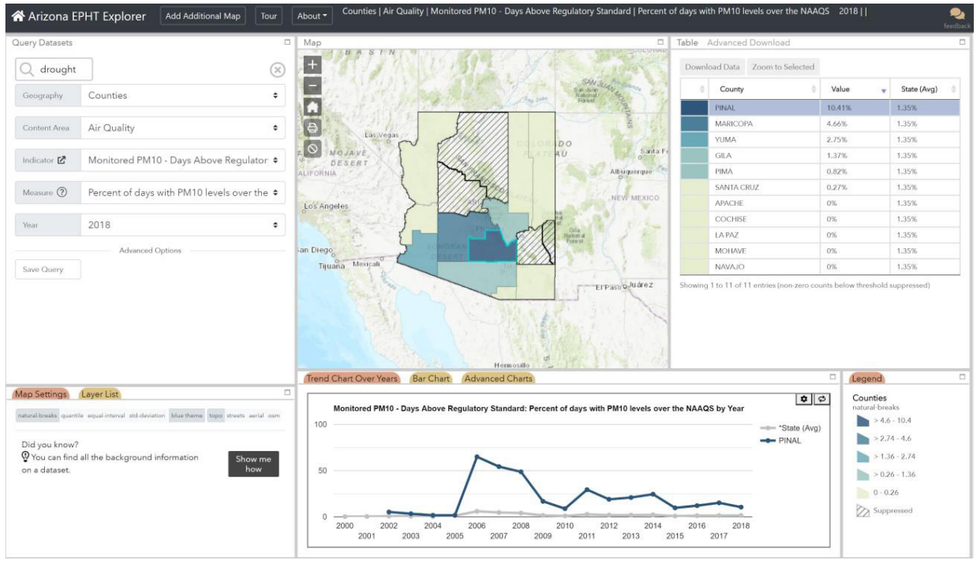


Figure 22. EPHT program also displaying Percent of Days Above NAAQs for PM 10 by County in 2018.

The EPHT program also developed another tool to track environmental health conditions, such as heat-related illness and asthma, called Quick Reports. This tool provides a snapshot of current data in your area in infographic form **(Fig. 23)**.

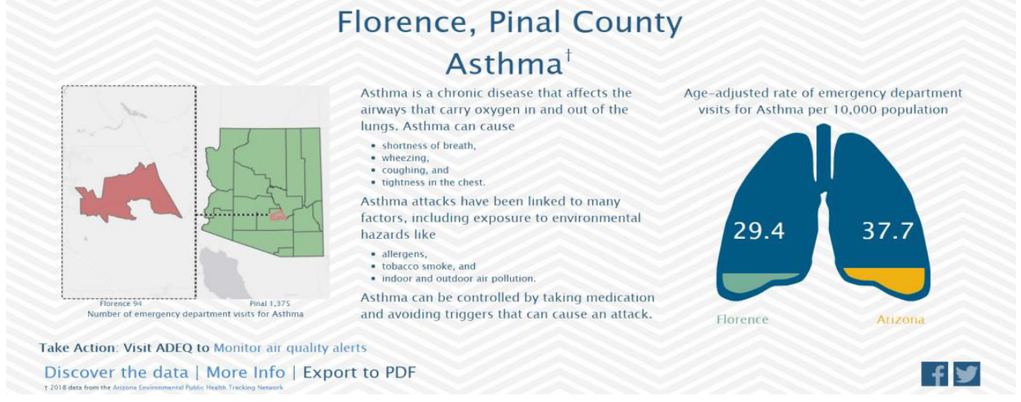


Figure 23. Example of AZDHS EPHT Quick Reports tool displaying asthma information for Florence, Pinal County.

CLIMATE AND HEALTH

ADHS has been a recipient of the CDC's Climate Ready States and Cities Initiative grant since 2010. Grantees follow the CDC's Building Resilience Against Climate Effects (BRACE) Framework, which is a five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate-sensitive hazards including drought **(Fig. 24)**.

Since its implementation, ADHS has partnered with Arizona State University and the University of Arizona to produce reports such as a Profile on Extreme Weather, Climate and Health; Climate and Health Since its implementation, ADHS has partnered with Arizona State University and the University of Arizona to produce reports such as a Profile on Extreme Weather, Climate and Health; Climate and Health Adaptation Plan; and an Assessment of Climate and Health Impacts on Vector-Borne Diseases and Valley Fever in Arizona.[16] Most recently, the addendum to the Climate and Health Adaptation Plan 2018 was published which outlined grantee activities; including implementing a monitoring strategy for heat-related illness in Pinal County and for battling Arizona heat with cooling centers in Yuma County.[17] In addition to this work, ADHS partners with the National Weather Service, county health departments, universities, and other environmental health partners to hold the annual State Heat Meeting to discuss planning efforts regarding the challenges of heat in Arizona.[18]

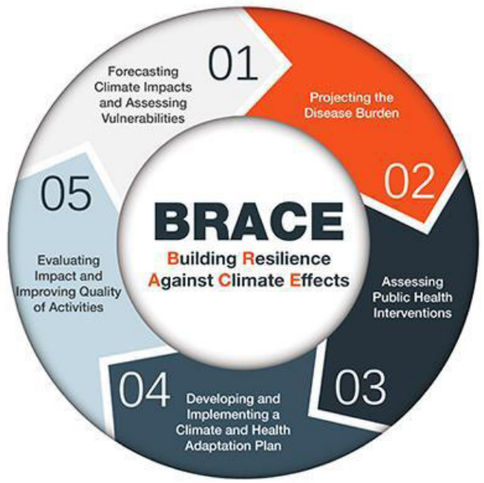


Figure 24. CDC BRACE Framework

WELL WATER SAFETY

The safety of well water can be threatened during drought conditions. Droughts produce conditions that can exacerbate wildfires or flooding events. High temperatures can increase wildfires and burned areas are susceptible to flash floods from burn scars. A wildfire can damage well components and mobilize pollutants into aquifers. A flood may contaminate wells with surface water, which can carry sewage and runoff from farms or waste disposal sites.

ADHS provides domestic well water workshops in communities throughout the year to discuss water sources, regulations, domestic well maintenance, and water treatment topics through the CDC's Safe Water for Community Health (Safe WATCH) Grant.[19] More than 1,200 well owners have attended workshops in the state. Private well owners can review guidance on where to get their private well water tested for bacteria, nitrates, arsenic, fluoride, and uranium and how to treat their contaminated well. Additionally, with funding from the Safe WATCH grant, ADHS has been able to provide well water and health safety information to newly registered well owners, through ADWR, by way of a USB thumb drives with information on testing, treatment, and health effects. This includes a well owner guide which describes Arizona's drought impacts on well water and health.[20]

FOOD SAFETY

In Arizona, food establishments and schools have been identified as the areas with greatest potential for drought-related impacts due to insufficient quality or quantity of water supplies for food preparation and personal hygiene. In light of the COVID-19 pandemic, ADHS has prepared guidance documents on hygiene and food safety for schools and restaurants returning to dine-in options.[21] ADHS also provides guidance on how to safely operate food establishments and schools during a community water outage.

[16] https://www.azdhs.gov/preparedness/epidemiology-disease-control/extreme-weather/index.php#news-publications

[17] https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/extreme-weather/pubs/addendum-to-az-climate-health-adapt-plan.pdf

[18] https://journals.ametsoc.org/bams/article/100/3/ES101/343717/Cross-Sector-Management-of-Extreme-Heat-Risks-in

[19] http://www.cdc.gov/nceh/ehs/safe-watch/index.html

[20] https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/environmental-toxicology/well-water/arizona-well-owners-guide.pdf

[21] https:www.azdhs.gov/documents/preparedness/epidemiology-disease-control/infectious-disease-epidemiology/novel-coronavirus/adhs-guidance-for-restaurants.pdf

3.H. ADWR OUTREACH AND ASSISTANCE

ADWR LEADERSHIP DROUGHT RELATED ACTIVITIES

During Water Year 2020, Tom Buschatzke, ADWR Director, and Clint Chandler, ADWR Deputy Director, actively promoted drought preparedness efforts and activities around the State not only by leading many of these efforts, but also by discussing and presenting on these activities to a wide array of stakeholders, groups, and organizations, as those listed below. Their discussions included topics such as Arizona's Reconsultation Committee, Governor Ducey's Water Augmentation, Innovation & Conservation Council, Arizona's water resource challenges, and the probabilities of a Lower Colorado River Basin shortage. ADWR is committed to transparency and is passionate about providing water information to interested parties.

- University of California, Berkeley Law Symposium, September 10, 2019
- Colorado River Symposium, September 12, 2019
- 2019 Arizona Hydrological Society Symposium, September 26, 2019
- Southern Arizona Water Users Association, October 11, 2019
- 2019 Salton Sea Summit, October 17, 2019
- OneAZ Credit Union Educational Engagement, October 29, 2019
- Arizona House of Representatives: Committee on Natural Resources, Energy & Water, January 14, 2020
- Arizona State Senate: Water & Agriculture Committee, January 16, 2020
- WRRC Annual Conference, June 18, 2020
- NGA Water-Energy Nexus Learning Lab, September 2, 2020

ADWR COMMUNICATION ACTIVITIES

ADWR promotes and encourages efficient use of water throughout Arizona by developing conservation tools and resources, assisting Arizona communities and water providers, presenting on drought and conservation issues and solutions, collaborating with regional and national partners, and participating in outreach activities. Staff provides materials and answers inquiries from the public, businesses, press, water professionals, students, researchers, and others about water conservation and drought. Below are a few highlighted efforts and activities by ADWR staff during Water Year 2020 that promoted water conservation and awareness:

ADWR DROUGHT WEBPAGES

ADWR's Drought Webpages feature the weekly, monthly, and quarterly drought statuses for Arizona as well as updates regarding MTC, ICG, and LDIG activities. The website also provides a historical background on drought planning in Arizona, and an archive for past drought preparedness annual reports that are easily accessible to the public.

ARIZONA WATER NEWS

ADWR's Arizona Water News **(Fig.25)**, a weekly newsletter featuring articles regarding the latest on Arizona and Colorado River water-related issues, was launched in March 2016. The newsletter articles help stakeholders stay up to date on the latest developments regarding Arizona water. Since its launch, Arizona Water News articles have received over 81,496 views.

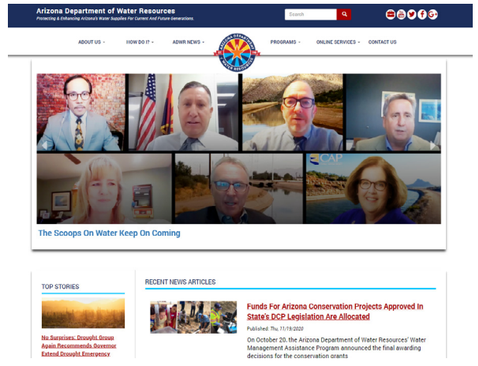


Figure 25. Arizona Water News

WATER AWARENESS MONTH

ADWR has coordinated Arizona's Water Awareness Month campaign since the Governor's executive order in 2008. This year, due to the COVID-19 pandemic, the in-person kick-off event was canceled. However, ADWR adapted its campaign to include virtual alternatives such as distributing free educational materials through social media, Arizonawaterfacts.com and other platforms.

INTERACTIVE DROUGHT DASHBOARD

ADWR's Drought Program debuted a new Interactive Drought Dashboard **(Fig. 26)** that depicts short-term drought conditions in Arizona from 2000 to the present. This tool utilizes U.S. Drought Monitor maps and allows users to explore drought conditions for the entire period or for specific time frames. Viewers can access drought data on the state as a whole, or on a selected county.

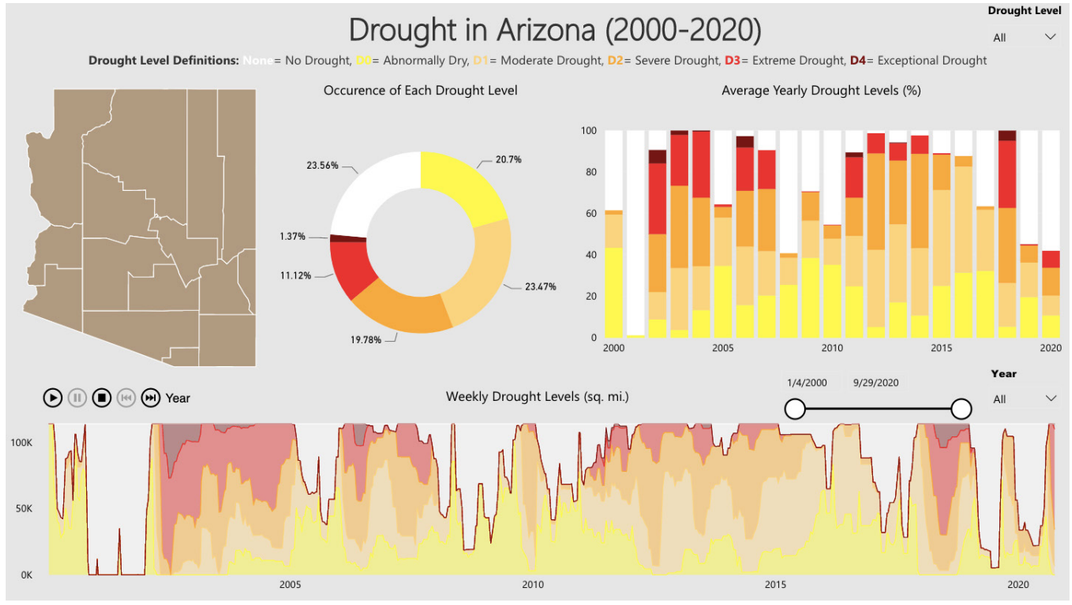


Figure 26. Arizona Department of Water Resources Interactive Drought Dashboard.

ARIZONA WATER FACTS WEBSITE

On June 1, 2016, ADWR launched Arizonawaterfacts.com **(Fig. 27).** This website is dedicated to promoting Arizona's success in managing its water resources, presenting current water resource challenges, and planning for the future. Arizona Water Facts is intended to build confidence in our water resources – a necessity for fostering a thriving economy and for a healthy livelihood.

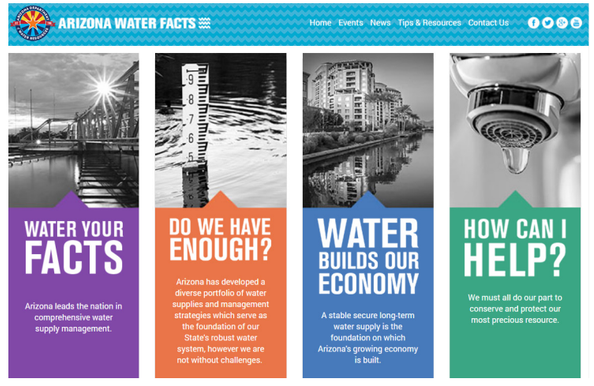


Figure 27. Arizona Water News

APPENDIX A

NATURAL RESOURCES CONSERVATION SERVICE

2020 NATURAL RESOURCES DROUGHT REPORT

USDA

HAVASUPAI FALLS

2020 NATURAL RESOURCES CONSERVATION SERVICE DROUGHT REPORT

USDA-Natural Resources Conservation Service, Phoenix, AZ
Prepared by Kenneth Gishi, State Rangeland Management Specialist

Precipitation totals for Water Year 2020 (October-September) ranged from below normal to above normal across most of the state with some portions in eastern and central parts reporting well below average conditions for the Water Year. The 2020 Winter precipitation was mostly well above normal to above normal across most of the state due early winter storms events and several spring storms. These storm events benefited most of the state with exception to portions of the northeastern regions of the state. The Four Corners region continued with drought conditions throughout the year. The 2020 Monsoon was one of the hottest and driest on record with several NRCS field offices reporting minimal monsoon activity. Total precipitation for June-September was well below average across much of the state. Despite a wetter than normal winter, the higher than normal summer temperatures and very dry monsoon saw a return of drought designations to most of the state. Several field offices reported very little effective rainfall after May, which resulted in poor summer forage conditions. In early September 2020, a drought survey was sent to all field offices to assess drought conditions in the work area. Field offices used information from conservation planning activities, conservation district boards, local farmers and ranchers, and additional input from other stakeholders. Of the 24 Arizona NRCS field office areas, 22 survey reports were returned at the time of this report.

FORAGE LOSS

Reporting field offices were asked to assess spring forage production and expected summer (end of season) forage production. Of the 22 responding offices, 21 field offices reported rangeland forage production shortages **(Fig. 1)** this past year. There were 17 offices reporting less than 50 percent of normal forage production for the summer growing season. No offices reported more than 75 percent of normal forage production for this past growing season. The wet winter resulted in 6 offices reporting normal to above normal spring forage production.

Summer monsoon moisture was minimal and, in some areas, was very sporadic. Some reporting areas noted that little or no rainfall was observed during the months of June, July or August. Some rain events did occur in the far southern portions and higher elevations of central and eastern areas of the state. The majority of the field offices continued to report below average forage conditions, largely due to current drought conditions and past drought effects on forage species in recent years. Offices that had a wetter than normal winter and spring reported that any benefits of cool season perennial forage production were offset by the lack of summer production.

Figure 1.

Overall, the very dry monsoon, record high temps and wildlife impacts resulted in worse forage conditions than last year with an estimated 65-70 percent forage loss statewide, as compared to last year's estimated 45-50 percent at this time last year. This estimation is based on field office reports, rainfall data and preliminary rangeland inventory data for this past forage year. **Table 1** below shows the field office survey responses related to rangeland forage supply.

Table 1. Forage Production Supply by Field Office

Field Office	Percent of normal forage production available this past spring?	Percent of normal forage production expected by the end of growing season?	Percent of normal livestock being grazed?	Percent of ranchers feeding supplemental forage?
Avondale	76-100%	26-50%	76-100%	26-50%
Casa Grande	76-100%	51-75%	26-50%	26-50%
Chandler	26-50%	26-50%	26-50%	>75%
Chinle	1-25%	1-25%	0-25%	No Response
Dilkon	51-75%	26-50%	51-75%	51-75%
Douglas	>100%	51-75%	76-100%	0-25%
Flagstaff	51-75%	26-50%	51-75%	>75%
Fredonia	51-75%	1-25%	51-75%	0-25%
Holbrook	26-50%	1-25%	0-25%	51-75%
Keams Canyon	51-75%	26-50%	51-75%	51-75%
Kingman	>100%	1-25%	51-75%	51-75%
Prescott Valley	26-50%	1-25%	51-75%	0-25%
Safford	76-100%	1-25%	51-75%	0-25%
San Carlos	>100%	26-50%	51-75%	26-50%
Sells	26-50%	1-25%	0-25%	51-75%
Shiprock	51-75%	26-50%	51-75%	>75%
Springerville	26-50%	1-25%	0-25%	>75%
St Michaels	51-75%	26-50%	51-75%	>75%
Tucson	76-100%	51-75%	51-75%	51-75%
Whiteriver	51-75%	51-75%	0-25%	0-25%
Willcox	>100%	1-25%	51-75%	51-75%

PRECIPITATION

The 2020 Water Year total precipitation alone is usually not very helpful for estimating rangeland production due to seasonal variability and growth patterns of major forage species. This can be expressed by looking at precipitation data by growing seasons. In Arizona, the months June through September are the warm season growing period and October through May are the cool season growing season. When compared to 30-year normal for October through September (water year) and summarized by growing season, the normal precipitation can explain some of the seasonal variability where overall precipitation is above or below normal. See **Table 2** for the 2020 Water Year precipitation with winter/spring and summer growing seasons expressed as percent of normal.

Table 2. Forage – Water Year Precipitation with Seasonal Percent of Normal

Station	County	Office Area	2020 WY Total Precipitation (Oct-Sept)	2020 WY Percent Normal	Percent Normal Precipitation (Oct-May)	Percent Normal Precipitation (June-Sept)
Canyon de Chelly	Apache	Chinle	5.51	57%	71%	31%
Painted Desert NP	Apache	Springerville	8.73	81%	125%	26%
Springerville	Apache	Springerville	7.21	61%	76%	52%
Saint Johns	Apache	Springerville	6.35	60%	109%	20%
Alpine	Apache	Springerville	11.31	52%	63%	42%
McNary 2 N	Apache	Whiteriver	19.19	73%	103%	31%
Douglas	Cochise	Douglas	21.08	152%	362%	23%
Douglas FAA AP	Cochise	Douglas	10.12	77%	176%	17%
Coronado NM HQ	Cochise	Douglas	23.72	108%	164%	62%
San Simon	Cochise	Willcox	10.47	95%	133%	57%
Willcox	Cochise	Willcox	13.13	99%	148%	51%
Wupatki NM	Coconino	Flagstaff	3.15	37%	62%	11%
Flagstaff AP	Coconino	Flagstaff	17.31	79%	116%	21%
Walnut Canyon NM	Coconino	Flagstaff	9.74	52%	90%	6%
Williams	Coconino	Flagstaff	17.73	79%	110%	30%
Payson	Gila	Chandler	13.9	77%	117%	28%
Pleasant Valley RS	Gila	Chandler	15.62	71%	106%	16%
Natural Bridge	Gila	Chandler	17.93	84%	110%	34%
San Carlos Reservoir	Gila	San Carlos	14.99	101%	131%	45%
Safford Ag Ctr	Graham	Safford	6.54	68%	118%	15%
Fort Thomas 2SW	Graham	Safford	7.88	75%	112%	22%
Duncan	Greenlee	Safford	9.93	84%	132%	36%
Alamo Dam	La Paz	Avondale	8.95	101%	146%	28%
Quartzite	La Paz	Avondale	4.87	98%	154%	4%
Parker	La Paz	Parker	4.88	96%	132%	0%
Phoenix Sky Harbor	Maricopa	Avondale	6.8	85%	109%	37%
Fountain Hills	Maricopa	Chandler	11.11	95%	135%	2%
Beaver Dam	Mohave	Fredonia	8.81	123%	163%	0%
Pipe Springs NM	Mohave	Fredonia	11.83	108%	154%	12%
Kingman	Mohave	Kingman	7.36	88%	128%	9%
Lake Havasu City	Mohave	Kingman	6.65	173%	222%	0%
Wikieup	Mohave	Kingman	9.012	97%	123%	22%
Winslow AP	Navajo	Holbrook	6.96	99%	175%	14%
Petrified Forest NP	Navajo	Holbrook	7.99	76%	132%	20%
Heber RS	Navajo	Holbrook	15.04	81%	108%	49%
Show Low AP	Navajo	Springerville	14.66	88%	140%	29%
Organ Pipe NM	Pima	Avondale	11.69	114%	173%	50%
Ajo	Pima	Avondale	10.38	152%	199%	82%
Tucson 17 NM	Pima	Tucson	7.3	60%	92%	28%

Table 2. Forage – Water Year Precipitation with Seasonal Percent of Normal (continued)

Station	County	Office Area	2020 WY Total Precipitation (Oct-Sept)	2020 WY Percent Normal	Percent Normal Precipitation (Oct-May)	Percent Normal Precipitation (June-Sept)
Ashurst Hayden Dam	Pinal	Tucson	9.06	88%	128%	8%
San Manual	Pinal	Tucson	8.97	64%	115%	15%
Nogales 6N	Santa Cruz	Tucson	13.34	74%	103%	54%
Tumacacori NM	Santa Cruz	Tucson	18.7	113%	132%	99%
Seligman	Yavapai	Flagstaff	9.9	77%	135%	6%
Montezume Castle NM	Yavapai	Flagstaff	11.69	81%	130%	13%
Jerome	Yavapai	Flagstaff	17.56	94%	128%	42%
Prescott Love Field	Yavapai	Prescott Valley	10.37	72%	162%	15%
Prescott	Yavapai	Prescott Valley	13.9	77%	117%	28%
Bagdad	Yavapai	Prescott Valley	16.66	100%	140%	16%
Tacna 3 NE	Yuma	Yuma	5.43	132%	205%	0%
Yuma Proving Ground	Yuma	Yuma	5.33	140%	209%	0%

Climate data from wrrc.dri.edu, percent of normal based on 1981 - 2010 monthly normal

RANGELAND WATER SUPPLY

Of the responding offices, 21 of the 22 reported livestock water shortages on rangelands **(Fig. 2)**. Water sources that were most affected are wells, springs, catchments, creek/rivers and ponds. Ten offices, shown on the map in red, reported 50 percent or more of the work area were out of livestock water with 5 of those offices experiencing more than 75 percent of the work without water. Other field office areas affected are shown in pink on the map.

Additionally, 13 of the 21 reporting field offices reported 50 percent or more of ranchers are hauling water for livestock. These are all increases in the number of field offices affected based on 2019 reports. Field Office work areas most affected include Chandler, Saint Michaels, Shiprock Chinle, Casa Grande, Holbrook and Springerville. These offices all have been experiencing overall livestock water supply shortages. **Table 3** shows a summary of field office responses to livestock water supplies.

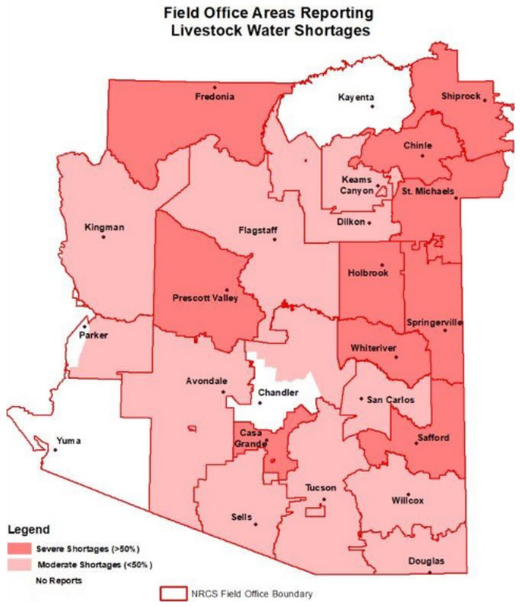


Figure 2.

Table 3. Rangeland Water Supply Status by Field Office Area

Field Office	Primary source of livestock water.	What % of the work area is out of livestock water?	What % of ranchers are hauling water?	What % of livestock wells are dry?	What % of dirt ponds are dry?	What % of springs are dry?	What % of capacity is available in all ponds?
Avondale	Well/Pipelines	26-50%	0-25%	0-25%	>75%	51-75%	26-50%
Casa Grande	Well/Pipelines	51-75%	51-75%	26-50%	>75%	>75%	No Data
Chandler	Combination	26-50%	>75%	>75%	>75%	>75%	>75%
Chinle	Well/Pipelines	>75%	>75%	>75%	>75%	>75%	No Data
Dilkon	Well/Pipelines	26-50%	51-75%	0-25%	>75%	26-50%	0-25%
Douglas	Well/Pipelines	0-25%	0-25%	0-25%	26-50%	26-50%	50%
Flagstaff	Pond (dirt tank)	26-50%	51-75%	0-25%	26-50%	51-75%	50-60%
Fredonia	No Response	>75%	>75%	0-25%	>75%	0-25%	5%
Holbrook	Well/Pipelines	51-75%	51-75%	26-50%	>75%	>75%	0-25%
Keams Canyon	Well/Pipelines	26-50%	51-75%	0-25%	>75%	26-50%	0-25%
Kingman	Well/Pipelines	0-25%	0-25%	No Data	>75%	26-50%	0-25%
Prescott Valley	Well/Pipelines	51-75%	51-75%	0-25%	51-75%	26-50%	0-25%
Safford	Well/Pipelines	51-75%	0-25%	0-25%	51-75%	26-50%	0-20%
San Carlos	No Response	26-50%	0-25%	0-25%	26-50%	51-75%	25%
Sells	Pond (dirt tank)	26-50%	51-75%	26-50%	26-50%	0-25%	26-50%
Shiprock	Well/Pipelines	>75%	>75%	51-75%	>75%	51-75%	No Data
Springerville	Well/Pipelines	>75%	51-75%	26-50%	>75%	>75%	0%
St Michaels	Well/Pipelines	>75%	>75%	51-75%	>75%	51-75%	No Data
Tucson	Well/Pipelines	26-50%	0-25%	0-25%	51-75%	51-75%	10%
Whiteriver	Pond (dirt tank)	51-75%	0-25%	0-25%	26-50%	No Data	26-50%
Willcox	Well/Pipelines	0-25%	0-25%	0-25%	26-50%	26-50%	20%

DRYLAND FARMING

There were seven responding field offices that reported drought conditions affecting dryland crops as depicted on the map **(Fig. 3)**. These offices are all located on Tribal lands across the state. It is estimated that 59 percent average crop production loss on approximately 20,000 acres of dryland cropland. Field office work areas affected were the Shiprock, Saint Michaels, Dilcon, Keams Canyon, Sells, and Whiteriver. Crops that were most affected are corn, squash, melons, beans and fruit trees.

IRRIGATION CROPLAND

This past water year, 12 responding field offices reported irrigation water shortages in the work area as depicted on the map **(Fig. 4)**. It was estimated a 40 percent average crop production loss on over 82,000 acres of irrigated cropland, pastureland, and orchards. Crops that were affected are alfalfa, corn, cotton, small grains, beans, nut and fruit orchards, melons and irrigated pastures. Water sources most affected were wells, surface diversions from reservoirs and streams.

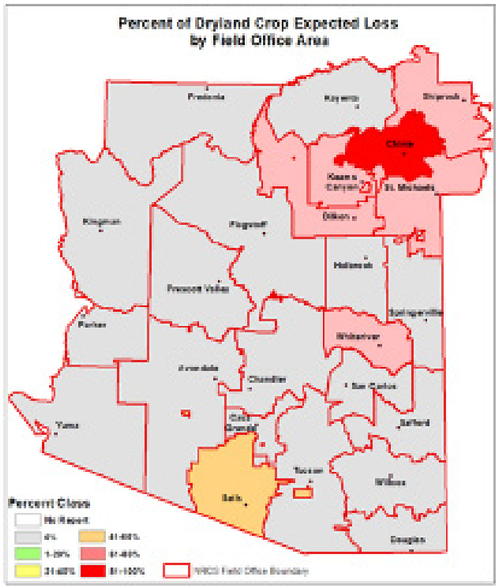


Figure 3.

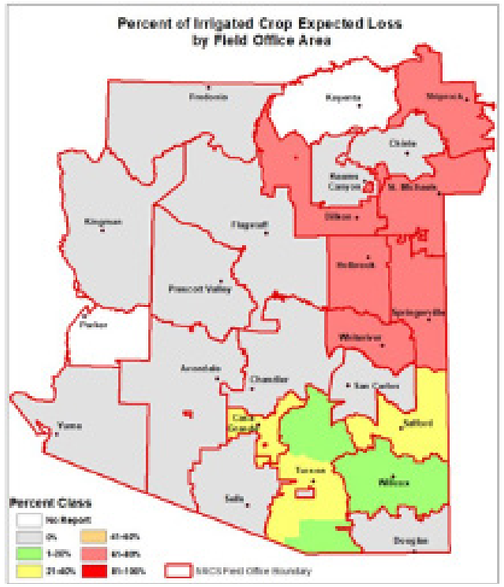


Figure 4.

OBSERVATIONS FROM FIELD OFFICE REPORTS

- Winter and spring precipitation produced well above to normal spring forage, however very little precipitation after April resulted in very poor perennial summer forage. Some monsoon activity provided very little relief, however some areas recorded little or no rains throughout the summer months. It was noted that some areas had record high temperatures and the driest summer on record.
- There were reports of very low perennial grass production and poor vigor. In some areas there were reports of perennial grass, particularly blue grama and trees like juniper and pinyons beginning to die out. For some areas this has been the second or third year with below forage amounts and many ranchers have had to reduce livestock numbers, adjust rotations, or provide supplemental feed.
- The lack of summer rains and high temperatures resulted in dirt tanks and smaller ponds going dry. This has also resulted in wells and springs being weakened and not providing sufficient livestock water. It is estimated that approximately 46 percent of ranchers are hauling water for livestock needs.

APPENDIX B

PIMA COUNTY

PIMA COUNTY

LOCAL DROUGHT IMPACT GROUP

2020 ANNUAL REPORT


PIMA COUNTY

INTRODUCTION

This report summarizes drought conditions in Pima County for Water Year 2020. The water year is from October 2019 through September 2020.

The Pima County Local Drought Impact Group (LDIG) has been an active component of County operations since 2006 when the Board of Supervisors adopted the Drought Response Plan and Water Wasting Ordinance (Pima County Code Chapter 8.70). LDIG consists of water providers, local, state and federal agencies and citizen groups that have an interest in the cause and effect of drought conditions in Pima County.

LDIG explores the impacts of drought on various sectors in Pima County including agricultural water use, ranching, wildfire, hydrology, and flooding. Because many water providers depend on Central Arizona Project (CAP) water, LDIG also monitors the status of the Colorado River, the El Niño Southern Oscillation (ENSO) and other climate weather patterns in relation to their effect on drought conditions and climate variability in the southwest. LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs. For a list of presentations and agendas, please visit Pima County's LDIG website **(Fig. 1).**

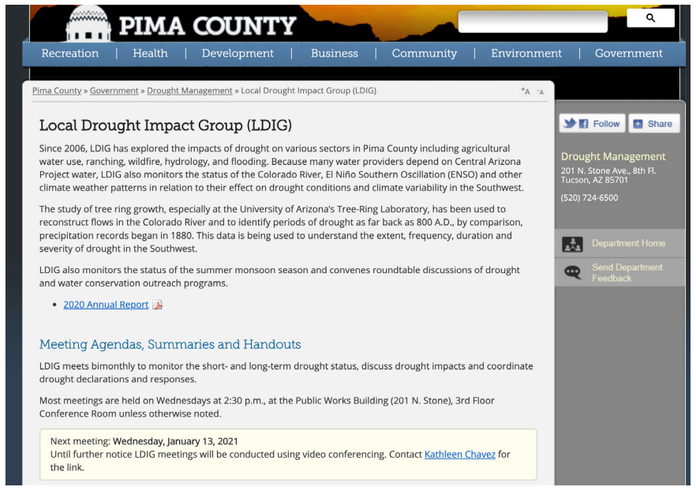


Figure 1. Pima County's LDIG Website

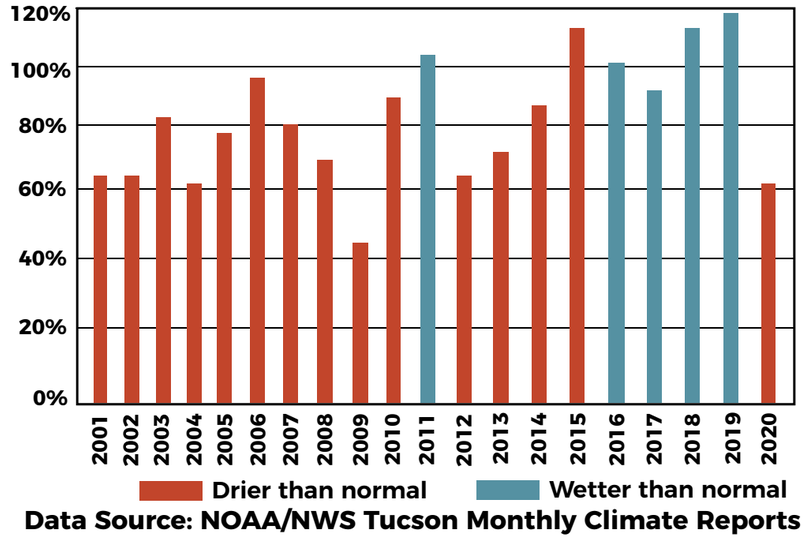
This report is submitted to the Arizona Department of Water Resources (ADWR) to be included in the 2020 Arizona Drought Preparedness Annual Report. It will also be provided to the Pima County Administrator's Office.

STATUS OF DROUGHT IN PIMA COUNTY

Drought is typically characterized by a lack of precipitation. Long-term drought conditions were evident in Pima County starting in the early 21st century. In 2006 Pima County approved a Drought Response Plan and Water Wasting Ordinance to have a framework in place, should drought persist and worsen. Drought has persisted in Pima County, but some years have been cooler, and others have been wetter than normal.

The National Oceanic and Atmospheric Administration's National Weather Service has maintained official records of temperature and precipitation at the Tucson International Airport since 1895. Although three of the last five years have been wetter than normal, only five of the last 20 years have experienced above normal precipitation as seen in **(Fig. 2).**

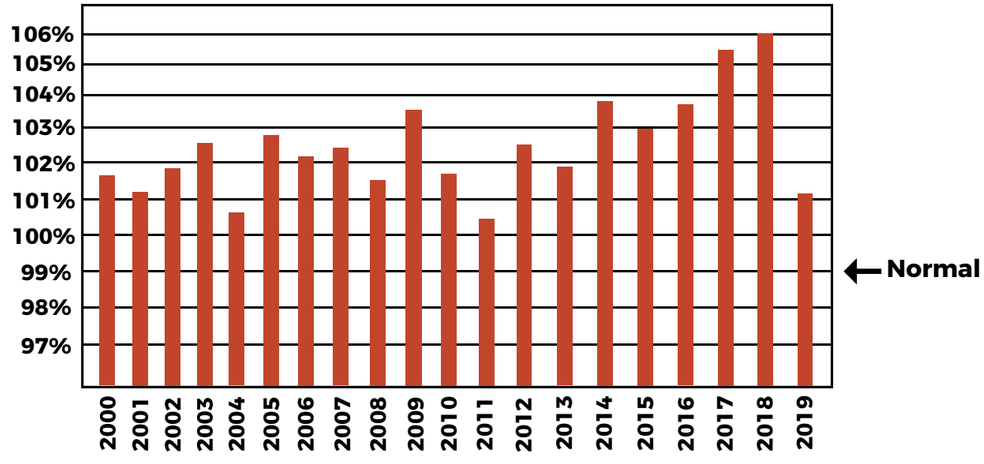
Figure 2 – Precipitation as % of Normal



Data Source: NOAA/NWS Tucson Monthly Climate Reports

Temperature also exacerbates drought impacts by increasing water demand and evapotranspiration in natural vegetation, landscape plantings, turf, and agricultural crops. Average annual temperatures have been above normal in each year since 2000, as depicted in **(Fig. 3)**. The years 2017 and 2018 have been the hottest on record, except for 2020 which is on track to be the hottest.

Figure 3 – Temperature as % of Normal



Data Source: NOAA/NWS Tucson Monthly Climate Reports

In 2007 Pima County and surrounding communities declared a Stage One Drought. In spite of persistent drought over the last 14 years, many sectors have endured and adapted to drought conditions, as described in this report. Pima County uses ADWR's Monthly Drought Status Summary and Quarterly Drought Status Update to define drought conditions. The monthly summary is produced by ADWR's Monitoring Technical Committee (MTC) and is based on the U.S. Drought Monitor's maps for the previous four weeks. The quarterly summary, also produced by the MTC, assesses drought status for each watershed determined by comparing precipitation and streamflow percentiles for the past 24, 36 and 48 months to a 40-year historical record. Short-term and Long-term drought conditions in Pima County are described below and summarized in **Table 1.**

Short-Term Drought Status – Water Year 2020 began with a mix of moderate to abnormally dry conditions in central Pima County. Drought intensity improved during the winter and spring due to near-normal precipitation. Above normal temperatures and below normal precipitation in summer resulted in worsening short term drought ranging from moderate in western Pima County to extreme in northeast Pima County.

Long-Term Drought Status – From October to December 2019, drought intensity in western Pima County was moderate, improving eastward with receding intensity of abnormally dry or no drought. By January 2020, moderate drought had receded in western Pima County with isolated areas of abnormally dry conditions and no drought in eastern Pima County. Drought intensity continued to recede through Spring with drought recovery in eastern Pima County and some areas of moderate drought in northeastern Pima County. However, record heat and below average precipitation in summer 2020 worsened long-term drought.

Table 1. Pima County Drought Intensity*

WY19-20	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sep
Short-Term	D0, D1	D0	No Drought							D1, D2	D1, D2, D3	D1, D2, D3
Long-Term	D0, D1			D0			D0, D1			D0, D1, D2, D3		

***D0-Abnormally Dry, D1-Moderate, D2-Severe, D3-Extreme, D4-Exceptional**

LDIG ACTIVITIES

LDIG typically meets six times during the year. However, the May meeting was cancelled due to Covid-19 pandemic and beginning in July the group met on an online meeting platform. Meeting agendas, summaries and presentation materials are posted to the LDIG website.

The County's Drought Response Plan and Water Wasting Ordinance establishes four stages and corresponding drought actions or measures: Stage 1-Water Alert, Stage 2-Water Warning, Stage 3-Water Emergency and Stage 4-Water Crisis. Each stage declaration prompts increased drought response actions.

2020 WEATHER CONDITIONS

Using data from the National Weather Service Tucson Office, Pima County weather conditions began the water year warmer and drier than normal on average, but with periods of cool winter storms with fair precipitation. October 2019 was slightly above average temperature with below average low temperatures. Isolated light storm systems brought below normal precipitation. November was warm and dry, but active winter storm systems from tropical moisture altered the pattern to wetter than average precipitation. However, above average monthly temperatures continued. In all, Fall was wetter and warmer than average. Several winter weather systems resulted in slightly wetter and warmer than average conditions in December.

January 2020 had no significant storm systems and produced below average precipitation with slightly warmer than average high temperatures and below average low temperatures. Winter was slightly warmer than average and lack of storm systems resulted in below normal precipitation. February ended warm and dry and those conditions continued into March.

April temperatures increased and below average precipitation continued. May experienced record hot temperatures; 4.7˚F above normal, ten days in excess of 100˚F and four days with highs of 105˚F or warmer. On June 5, a storm system ignited the Bighorn wildfire north of Tucson and warm, dry conditions along with wind patterns impeded containment, burning 119,978 acres in the Santa Catalina Mountains. Full containment was achieved on July 23. Four smaller but serious lightning-caused wildfires occurred in the Tortolita Mountains during the summer 2020.

July was the hottest on record with 25 days exceeding 100˚F, 16 days exceeding 105˚F and three days with highs of 110˚F or warmer. There were 16 days in which the low temperature was 80˚F or warmer. The monsoon pattern failed to materialize resulting in precipitation well below average. August was even hotter, breaking additional temperature records and continued below average precipitation. There were 23 days with temperatures exceeding 100˚F, 22 days with temperatures exceeding 105˚F and four days with temperatures in excess of 110˚F. Sixteen days had low temperatures of 80˚F or warmer. September was the third consecutive month with record warm temperature. There were 14 days with temperatures exceeding 100˚F, 3 days exceeding 105˚F and one day in excess of 110˚F. There was no precipitation in September. Smoke from wildfires in the West produced many days of hazy skies.

The Summer Monsoon 2020 season was the hottest on record and second driest. There were 100 days with temperatures exceeding 100˚F and 57 days exceeding 105˚F; both are the highest summer totals on record. The monsoon season was dominated by a strong high pressure pattern resulting in below average precipitation. The water year ended with 7.30 inches of rainfall, the 15th driest. **Table 2** summarizes monthly precipitation and departure from normal. **Table 3** lists average monthly temperature and departure from normal monthly temperature.

The National Weather Service uses a 30-year period to calculate normal temperature and precipitation. Starting in 2021, new normal temperature and precipitation will be recalculated using data from 1991 through 2020. Preliminary new normal data indicate temperatures increasing and precipitation decreasing compared to the previous 30-year period, 1981 through 2010.

Table 2. Precipitation (in inches, recorded at Tucson International Airport)

WY19-20	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precipitation	0.01	2.32	1.20	0.65	0.67	0.70	0.07	0.01	0.05	0.46	1.16	0.00
Normal Monthly Precipitation	0.89	0.57	0.93	0.94	0.86	0.73	0.31	0.23	0.2	2.25	2.39	1.29
Departure from normal	-0.88	+1.75	+0.27	-0.29	-0.19	-0.03	-0.24	-0.22	-0.15	-1.79	-1.23	-1.299
Cumulative	0.01	2.33	3.53	4.18	4.85	5.55	5.62	5.63	5.68	6.14	7.30	7.30
Rank	28th Dry	7th Wet	37th Wet	62nd Dry	56th Wet	40th Wet	47th Dry	47th Dry	50th Dry	10th Dry	30th Dry	Dry

Table 3. Average Temperature (in ˚F, recorded at Tucson International Airport)												
WY19-20	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
Average Temperature	71.5	63.8	53.6	53.4	55.0	60.9	69.6	80.7	86.4	91.5	92.0	85.7
Normal Monthly Temperature	71.0	59.8	51.9	52.6	55.3	60.1	67.0	46.0	84.6	87	85.3	81.6
Departure from normal	+0.5	+4.0	+1.7	+0.08	-0.3	+0.8	+2.6	+4.7	+1.6	+4.5	+6.7	+4.1
Rank	38th Hot	9th Hot	29th Hot	30th Hot	51st Hot	32nd Hot	16th Hot	**Hot**	17th Hot	**Hot**	**Hot**	**Hot**

Table 4. 2019-2020 Season Ranking (NWS Tucson)					
WY19-20	**Fall**	**Winter**	**Spring**	**Summer**	**Monsoon**
Precipitation Rank	15th Wet	50th Wet	58th Dry	7th Dry	2nd Dry
Temperature Rank	15th Hot	26th Hot	5th Hot	Hottest	Hottest

COLORADO RIVER BASIN & CENTRAL ARIZONA PROJECT

Nine water providers in Pima County hold municipal and industrial entitlements to almost 183,000 acre-feet of CAP water. Agricultural users, the Tohono O'Odham Nation and Pascua Yaqui Tribe also have access and use CAP water. Consequently, the drought status of the Colorado River and potential for a shortage declaration is of interest to these sectors. With the Colorado River in a Tier Zero shortage, several local water providers are contributing to Arizona's 192,000 acre-feet reduction in CAP deliveries to comply with the Drought Contingency Plan. Water providers, community members, and agricultural interests in Pima County are also actively involved in the Arizona Reconsultation Committee for the Colorado River Interim Guidelines.

DROUGHT IMPACTS IN PIMA COUNTY

Drought affects many sectors. Below is a review of drought impacts observed in Pima County during the year.

Wildfire: On June 5, a lighting strike started the Bighorn Fire in the Santa Catalina Mountains affecting almost 120,000 acres. Several years of drought conditions, combined with above normal temperatures in May contributed to the wildfire's extent and severity, starting in the western, steep, rugged terrain in the Pusch Ridge Wilderness and burning east across the mountain range to Redington Road. Hot, dry, windy conditions made containment difficult, threatening communities in Oro Valley, Redington and the Catalina Foothills and forcing evacuations. Full containment was attained on July 23. The Pima County Regional Flood Control District (RFCD) has prepared a flood assessment identifying the Cañada del Oro Watershed at highest risk for downstream flooding and sediment and debris flow runoff.

Also in June, the Tortolita Fire, started by a lightning strike, burned 3,140 acres of high dry grass and brush in rugged land east of Dove Mountain in Marana. In August, three additional wildfires (started by lightning strike) occurred in the Tortolita Mountains. The Westridge Fire (480 acres), Dove Fire (942 acres) and Edwin Fire (137 acres) were all contained by the end of August.

Air Quality: In June, Pima County's Department of Environmental Quality issued an air pollution health watch for particulates due to fire smoke from the Bighorn and Tortolita Mountain fires. In September, wildfires in California caused smoke and hazy skies, but it was high enough to avoid detection at Pima County's air quality monitoring locations.

Groundwater: ADWR maintains groundwater index wells throughout the State, including two in Pima County; one along the Pantano Wash and one at the confluence of Fraguita Wash and Arivaca Creek.

Pima County RFCD monitors groundwater levels within various watersheds to help assess the effects of climate and land use changes on the overall health of floodplains in Pima County. There are a few areas of shallow groundwater in the region along Cienega Creek, Davidson Canyon, and Tanque Verde Creek. Groundwater levels have recovered in many of the areas since 2014 though there is an established long-term downward trend in groundwater levels for most of the areas. RFCD will continue to monitor to ascertain whether the more recent recoveries are just a temporary delay in a downward trend.

Tucson Water provides maps of annual water level monitoring programs in the Tucson basin and in Avra Valley. Groundwater levels in available City of Tucson wells are periodically measured to maintain long term records to assist in management of local groundwater resources.

Water Demand: Pima County is served by several water providers, the largest of which is Tucson Water. Metropolitan Domestic Water Improvement District, the Town of Oro Valley and the Town of Marana along with other water providers deliver municipal water to Pima County residents. As required by ADWR, each has approved Drought Response Plans in place and implement water conservation measures per the Fourth Management Plan of the Tucson Active Management Area. Tucson Water and the Town of Marana are updating their drought response plans.

Riparian Resources: Pima County has established several environmental restoration projects that provide drought relief using drought adaptive strategies.

Agua Caliente – Agua Caliente Park, located northeast of Tucson, has historic and cultural significance. The park's focal point is a natural artesian spring that feeds a creek and pond sustaining an abundant variety of oasis vegetation and habitat for native species. Varying flow rate from the spring necessitated augmenting the pond with well water. This year the pond was lined and refilled completing a key restoration project. Endangered Gila topminnow were released into the newly restored pond and are thriving in their new home.

Canoa Ranch – The Raúl M. Grijalva Canoa Ranch Conservation Park, located on the site of the original San Ignacio de la Canoa Grant, is a historic ranch listed in the National Registrar of Historic Places. In February, Pima County completed an ephemeral wetland to augment the reestablishment of the ranch's original pond. The wetland and pond are attracting wildlife and waterfowl. This is a first phase of a larger project to restore riparian habitat in the Santa Cruz River Floodplain.

Cienega Creek – Cienega Creek, in eastern Pima County, continues to show the impacts of sustained drought and shifts to seasonal patterns of flow. Pima Association of Governments' (PAG) reporting depicts the localized drought impacts on a shallow groundwater-dependent system and designated Outstanding Arizona Water, representing drought conditions for local wildlife habitat and human activities dependent on shallow groundwater. It is valuable for drought reporting to represent areas that do not benefit from artificial recharge and CAP.

PAG has monitored the Cienega Creek Natural Preserve since the mid-1990s to provide reliable trend analysis for the riparian area for water quality, groundwater and streamflow. Hot and dry June conditions typically represent the minimum extent of perennial flow within a year. In June 2020, PAG recorded 1.018 miles of flow in the monitored stretch of Cienega Creek, about 44% less flow than was recorded in June 2019, demonstrating an increased drought impact. This is only 11% of the 9.5-mile monitoring area which flowed perennially in 1985, revealing severe long-term impacts. In addition, an even lower flow extent for the monitoring year (July 2019 – June 2020) occurred in September 2019. PAG has only observed this

pattern three times, all likely the results of poor monsoon seasons or below average winter rains. With two of the three events occurring in the last two years, it will be valuable to observe any shifting trends in seasonal patterns. These patterns also highlight the importance of consistent seasonal monitoring.

There was no baseflow in the monitored stretches of Davidson Canyon, a major tributary to Cienega Creek, in June 2020, following sustained flows in September, December, and March. This was an improvement on the previous monitoring year, during which flows were only observed in March 2019. Different precipitation regimes impact Davidson Canyon and Cienega Creek, contributing to a balance of sustained flows in Cienega Creek.

Kino Environmental Restoration Project (KERP)–KERP harvests urban stormwater and controls flooding in Tucson. KERP covers 141 acres with 28 acres of open water and riparian habitat. A central pond captures stormwater and stores it for irrigation within the KERP basin and Kino Park. Although less stormwater was harvested this year, it is still being directed through the steam courses. Reclaimed water is available to this site, as a contingency measure.

Santa Rita Experimental Range–The University of Arizona's School of Natural Resources reports very dry conditions at the Experimental Range, where rainfall is closely monitored. Most rain gages were 35-45% of the long-term average for the period of June through August. This, coupled with extraordinarily hot July and August temperatures, has reduced grass production to about 10% of the average for the monsoon growing season. While there is a large amount of standing grass from summer 2019 for livestock to eat, there is also concern for fire through the winter season.

DROUGHT RESPONSE ACTIONS

Pima County continues to adhere to its policy framework on water resources and drought management. The framework includes goals and recommendations from several planning documents that are available on Pima County's Drought Management webpage; among these are:

- Drought Response Plan and Water Wasting Ordinance
- Sustainable Action Plan for County Operations
- Water & Wastewater Infrastructure, Supply and Planning Study, Action Plan and Post Action Plan Annual Report

As of now, the region's water providers and other entities with established drought plans are at Drought Stage One or its equivalent and are implementing voluntary reductions and engaging in water conservation education.

Ongoing regional collaboration to improve drought resiliency includes:

- The Lower Santa Cruz River Management Plan (LSCRMP) will develop a management strategy to balance flood risk management, drainage infrastructure protection, water recharge, recreation opportunities, and riparian habitat preservation for the Santa Cruz River from Grant Road to Trico Road. This multi-benefit project will maximize recharge of effluent within the channel. Stakeholder comments have been received and responsible parties are collaborating on a task list.
- Lower Santa Cruz River Basin (LSCRB), a 50/50 local share in-kind study with the Bureau of Reclamation that applies climate change models to water supply and demand scenarios, charting the potential range of water imbalance in the region and developing adaptive management strategies to address water supply and demand imbalances in the Tucson Active Management Area.
- City of Tucson Climate Emergency Declaration calling for acceleration of adaptation and resilience strategies, development of a climate action and adaptation plan, update of the city's greenhouse gas inventory and pursuit of strategies and actions to transition out of fossil fuel production, power generation and use within city operations.

SUMMARY

Pima County's above normal temperatures and below normal monsoon activity are in contrast to last year's conditions. Dry conditions and lightning resulted in five wildfires in the region during the 2020 summer months. Drought continues to persist in Pima County.

CATALINA MOUNTAINS, TUCSON

APPENDIX C

MOHAVE COUNTY LOCAL DROUGHT IMPACT GROUP 2020 ANNUAL REPORT

ANDREW BRISCHKE & BYRON STEWARD

INTRODUCTION

This report summarizes the Mohave Local Drought Impact Group (LDIG) activities conducted in 2020. From this primary author's understanding, the LDIG was an informal advisory body to the Mohave County Risk and Emergency Management Department in conjunction with the County Extension Office. In full transparency the University of Arizona (UA) County Extension Agent and primary author for this report, Andrew Brischke, is unaware of any formal LDIG board activities and is preparing this report in collaboration with Bryon Steward, Mohave County Risk and Emergency Management Department. For all intent and purposes, this primary author would consider the advisory board defunct.

In the past, Mr. Brischke and UA Climate Extension Specialist, Dr. Mike Crimmins, would survey the local ranching community bi-weekly or monthly (depending on season) to keep informed about current drought conditions and impacts. Due to an extremely low response rate, this practice has been discontinued since 2019, and has moved to more informal/irregular outreach in perceived to emergency drought situations (i.e. 2019 and 2020 monsoon season) order to help make recommendations and inform authors of the U.S. Drought Monitor (USDM) about local conditions.

BACKGROUND

Drought is more complex than simple precipitation deficits. Factors affecting drought include temporal and spatial variability of precipitation events, rainfall intensity, and temperature and cloud cover which influence evaporation. Similarly, drought impacts vary among different land uses. One way we describe drought is through time-scale and impacts (Table 1). On the USDM these are defined as "S" for short-term and "L" for long-term (Not shown in Figure 1) and correlate to different types of drought: meteorological (precipitation and temperature), agricultural (mainly short-term impacts to soil moisture and the ability to grow crops and forage), hydrological (long-term impacts to streamflow and reservoir storage), and ecological (long-term impacts to vegetation die-back and increased likelihood of wildfire).

The USDM also describes drought in terms of intensity and relative frequency of each. These categories are described as: Abnormally dry (D0), Moderate Drought (D1), Severe Drought (D2), Extreme Drought (D3), and Exceptional Drought (D4) **Table 1.**

Table 1. U.S. Drought Monitor severity categories and commonly associated impacts.

Category	Description	Possible Impacts
None	None	None
D0	Abnormally Dry	Going into drought • Short-term dryness slowing planting growth of crops or pastures • Coming out of drought • Some lingering water deficits • Pastures or crops not fully recovered
D1	Moderate Drought	• Some damage to crops pastures • Streams reservoirs on wells low, some water shortages developing or imminent • Voluntary water use restrictions requested
D2	Severe Drought	• Crop or pasture loss likely • Water shortages common • Water restrictions imposed
D3	Extreme Drought	• Major crop/pasture losses • Widespread water shortages or restrictions
D4	Exceptional Drought	• Exceptional and widespread crop/pastures losses • Shortage of water in reservoirs streams and wells creating water emergencies

Adapted from: http://droughtmonitor.unl.edu/AboutUSDM/DroughtClassification.aspx

AGRICULTURAL & ECOLOGICAL IMPACTS OF DROUGHT IN MOHAVE COUNTY

Drought is accumulative and in terms of agriculture (livestock production) and ecology (rangeland), it is very much seasonal. In order to tell a more complete story about agricultural and ecological impacts due to drought in Mohave County we need to look at where we started at the beginning of the year, and how those impacts from the 2019 drought are compounding impacts from the 2020 drought.

The overwhelming majority of Mohave County started Water Year 2020 in either Moderate or Severe Drought (D2 and D3) **(Fig. 1)**. Agriculture impacts from drought included losing an entire summer growing season. Livestock producers were short on warm-season forage and perhaps more devastating, short on water in their tanks. It was difficult to find any green-up across our rangelands. Our winter/spring growing season went quite well in Mohave County with enough precipitation to pull the county out of drought. Then, much like 2019, the 2020 monsoon failed to show up. Many of the impacts are the same, however they are compounded by missing out on the 2019 monsoon as well. Because we basically lost two consecutive growing seasons for warm-season perennial forages, high mortality rates for those forages are likely.

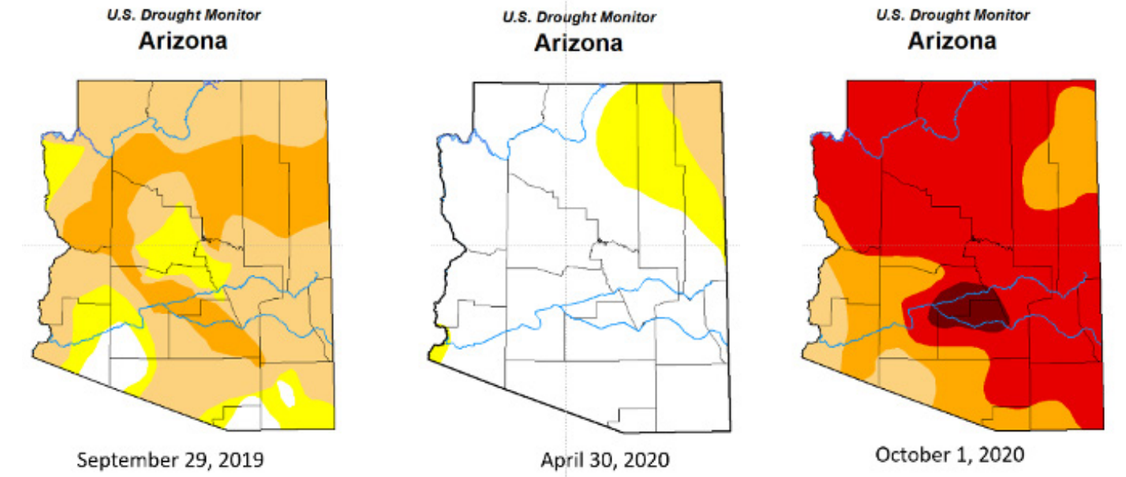


Figure 1. U.S. Drought Monitor from approximate end of bimodal agricultural growing seasons. https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?AZ

Another way to visualize how wet or dry periods can have lingering impacts years later is to look at accumulation over multiple time scales and intensity. One of this author's favorite tools to visualize drought accumulation is a Multi-scale Standardized Precipitation Index (SPI) Plot (aka "barf-chart"). SPI uses precipitation data to estimate drought. The standardized index typically ranges from -3 (dry) to 3 (wet) and is based on departure from the long-term average in standard deviations. SPI can be created for differing time-scale windows ranging from 1–60 months **(Fig 2)**, but here we're illustrating 1–36 months accumulation.

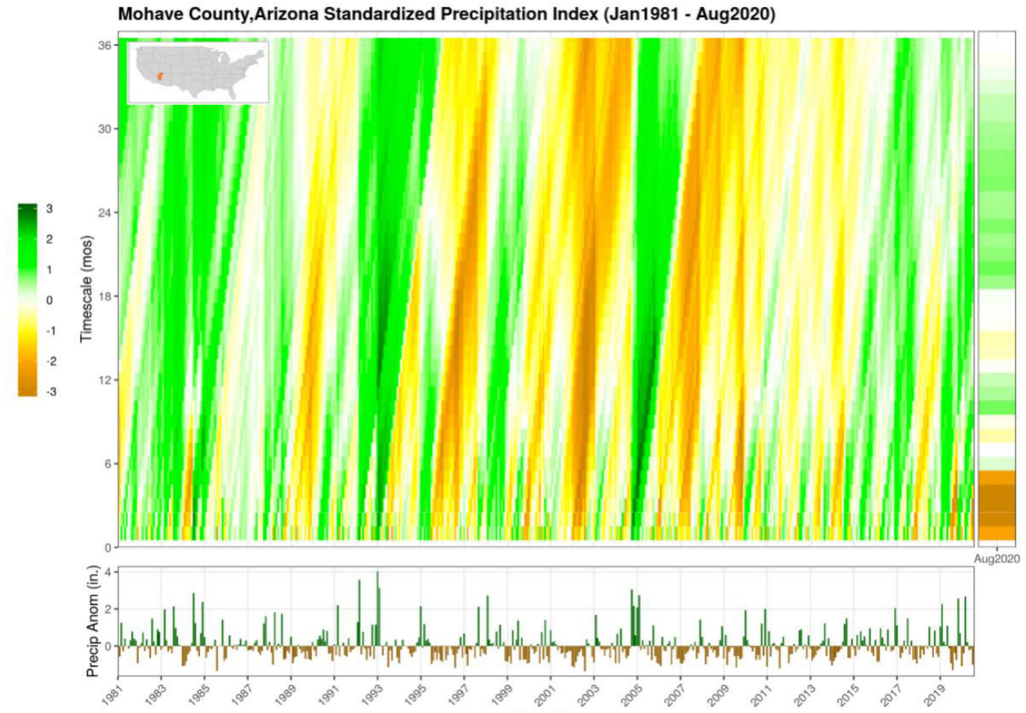


Figure 2. Multi-scale SPI Plot for Mohave County Jan. 1981 – Aug. 2020. Each pixel represents SPI value for the month of year (x-axis) and accumulation in months (y-axis). SPI values are based on standard deviations from the mean (https://uaclimateextension.shinyapps.io/SDIViz/).

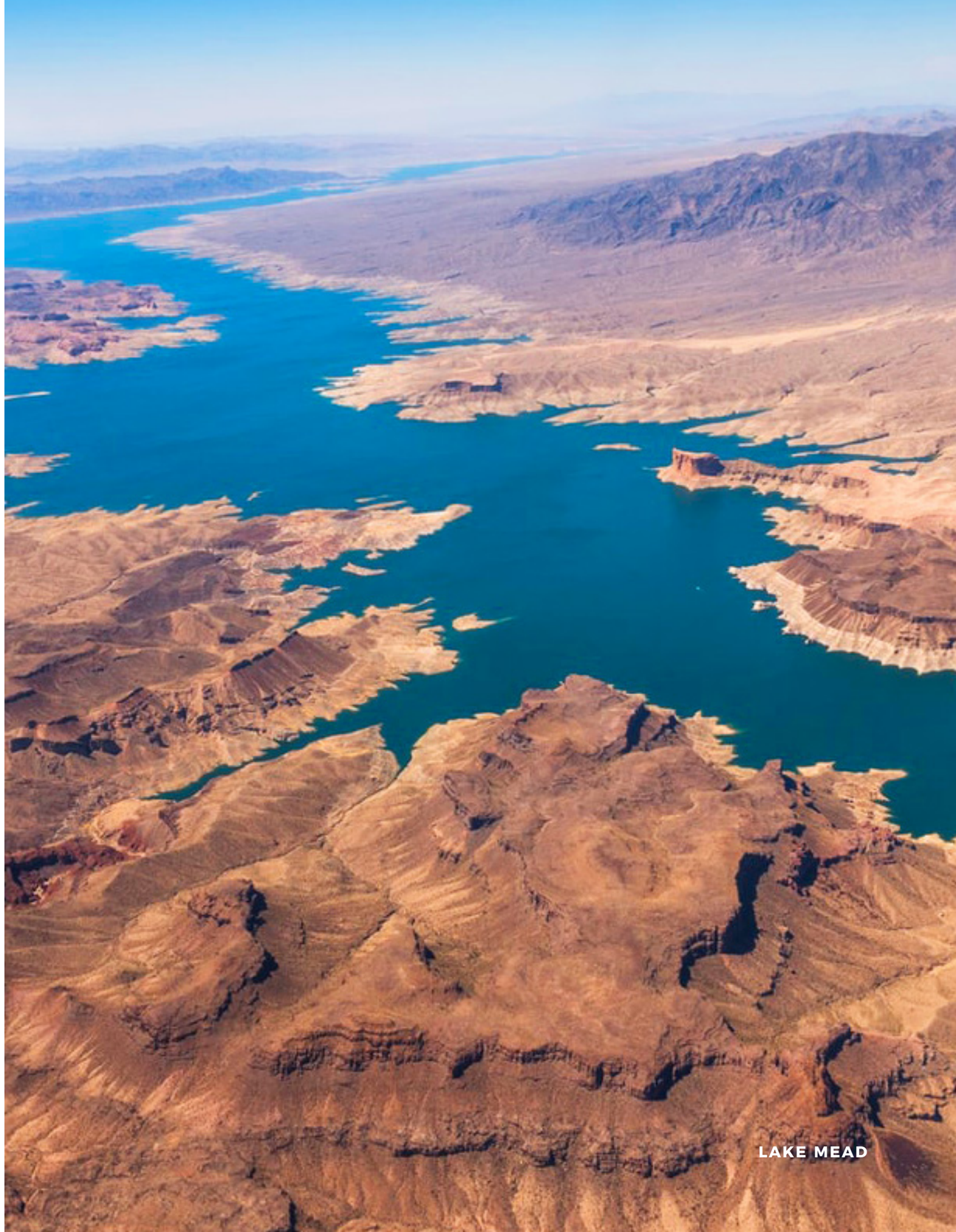
The multi-scaler plot illustrates how the variability of drought conditions over time at variable time scales. Generally, Mohave County has been in a decent position with respect to drought. However, recently, as mentioned above, seasonality matters. Unfortunately, our current climate patterns of lower than average monsoon precipitation is compounding the problem. Seasonal timing of precipitation is significant in this case. The intermittent relief periods shown in the plot were better than average winter/springs in 2019 and 2020, and have really been saving Mohave County from more devastating drought. But while the cool-season forage may be taking advantage of their growing season, the warm-season forage resources have quite literally been left out to dry.

EMERGENCY MANAGEMENT IN MOHAVE COUNTY

As of mid-September, the County remains at high risk of wildfires. On May 14, 2020, the Mohave County Board of Supervisors enacted a Consumer Fireworks and Open Fire Ban in the unincorporated areas of the county in conjunction with similar bans in place on State and Federal lands. Since that time, only a few isolated thunderstorms have provided small amounts of precipitation in localized areas. On August 20, 2020, the Board of Supervisors declared a State of Fire Emergency due to the Ridge Fire, which had been ignited by lightning in dense and dry vegetation about 5 miles south of the Pine Lake community and the Hualapai Mountain Park. Subsequent northward fire movement prompted closure of the Park to new visitors and preparations for possible evacuation of the community. The fire was contained and extinguished after burning over 3,000 acres through the efforts of Type 3 and Type 2 Incident Management Teams before any evacuations became necessary. It should be noted that the water well serving the Pine Lake community showed signs of depletion when being heavily used to provide fire suppression water during the fire.

Numerous other fires have been contained in 2020 through quick action of firefighters, including one on the Havasu National Wildlife Refuge that briefly threatened residences in the Mohave Valley community. Therefore, there have been no homes, businesses, or critical infrastructure impacted by wildfire this year to date. The fire emergency and the fireworks and open fire ban will likely remain in place until enough widespread precipitation occurs to mitigate the fire threat.

No water restrictions or other emergency conservation measures are in effect in the unincorporated area of Mohave County or in the cities.



LAKE MEAD

ARIZONA DEPARTMENT OF WATER RESOURCES

ARIZONA DROUGHT PREPAREDNESS
ANNUAL REPORT 2020

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OCTOBER 1, 2019 – SEPTEMBER 30, 2020